POWER PLANT ENGINEERING

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Isolated Plant for Chemical Factory

STEEL ENCASED BOILERS, UNDERFEED STOKERS AND FOUR-VALVE ENGINES MAKE FOR EFFICIENCY IN JOHN T. MILLIKEN & CO. PLANT

MANUFACTURING PHARMACEUTICAL chemicals and hospital supplies is the work carried on in the factory of John T. Milliken & Co., of St. Louis, Mo. In the various processes both power and heat are required, many of the heating processes require careful temperature regulation and both hot water and steam are used. The power plant that serves this new factory, though not large, is well equipped with modern machinery, excellently adapted for the services it performs. So well balanced is the power and heating load that during the six months the plant has been in operation there has at no time been more than a pound of back pressure on the engines, almost no escape of exhaust steam to atmosphere at any time and no live steam used in the house heating system.

Coal is delivered on railroad cars and dumped direct to a bunker of 200 tons capacity, the floor of which is a few feet above that of the boiler room, but an incline is provided down which trucks may be hauled to deliver the coal to the boiler room. Coal may also be delivered to the plant in wagons and dumped into the bunker from the alley.

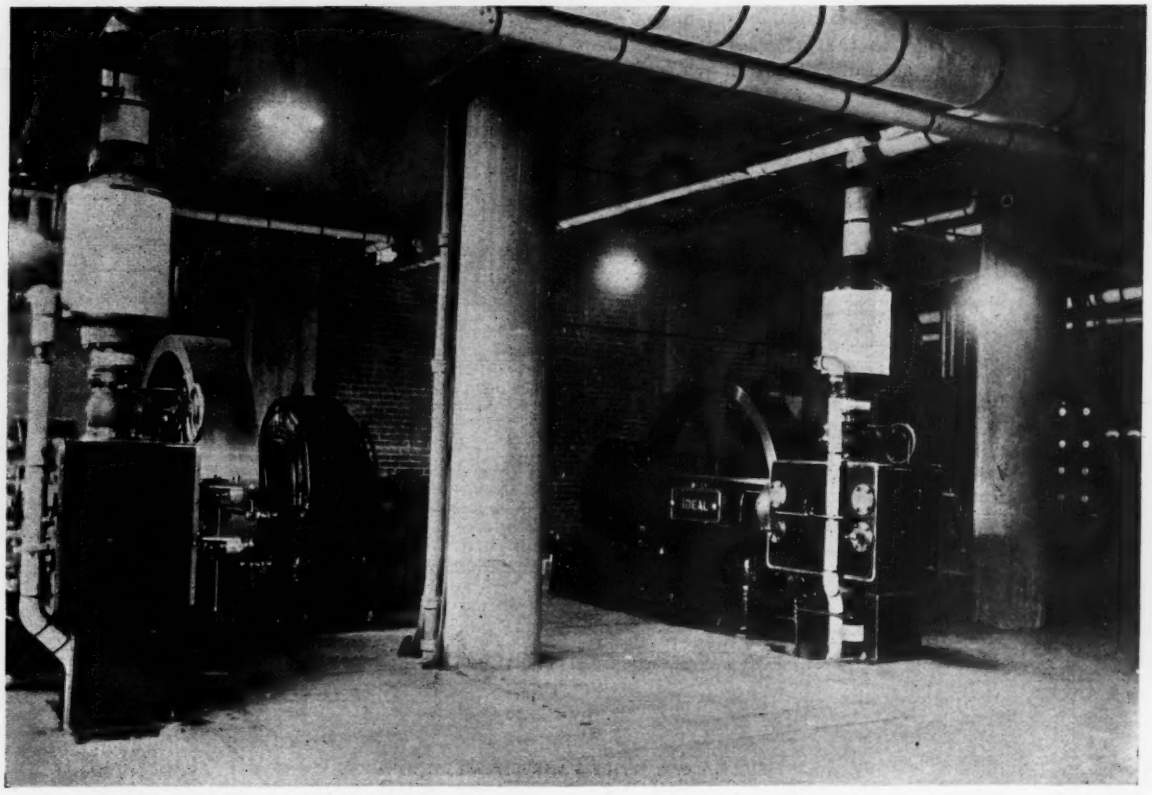


FIG. 1. VIEW IN ENGINE ROOM OF MILLIKEN PLANT

At present three boilers are installed with provision in the plant for one more. These were manufactured by the Houston, Stanwood & Gamble Co., and are of the return tubular type encased in fire brick lined steel settings with a 2½-in. layer of Nonpareil insulating brick between the casing and fire brick. Each is rated at 150 hp. and carries a steam pressure of 150 lb. gage.

The furnaces are equipped with Moloch underfeed stokers, which, together with the forced draft fan, are automatically controlled according to boiler pressure by timing device. The furnaces are designed for 200 hp. continuous operation.

To drive the fan, which is a No. 60 blower, manufactured by the Clarage Fan Co., and the timing device, a Troy vertical engine is employed.

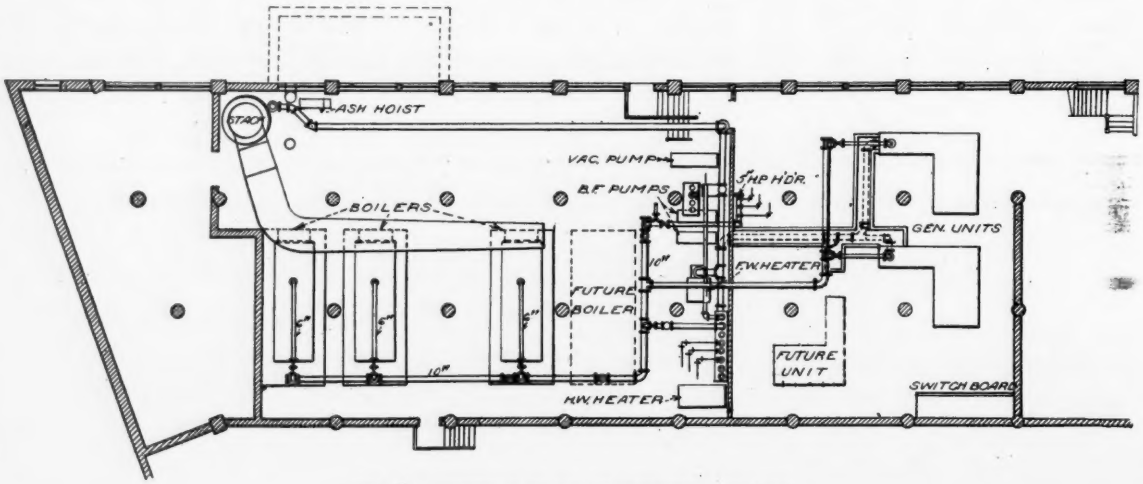


FIG. 2. GENERAL PLAN OF MILLIKEN PLANT

Among the boiler mountings are Williams high and low water alarm columns with automatic shut off gage glass valves; one pop safety valve to each boiler set to blow at 150 lb.; Golden-Anderson automatic shut off valve in the steam boiler lead in addition to the a valve in the steam line to the fan engine. Thus a lowering of steam pressure causes the automatic valve to admit more steam to the engine, increasing its speed also that of the fan, and causing more frequent operation of the stoker plunger through the medium of the gate valve; Homestead angle blowoff valve and cock in blowoff line; and a Bayer soot blowing system.

Blowoff water is discharged to a basin, vented to atmosphere, and then to a sump pit from which it is pumped to the sewer. Water used for washing the

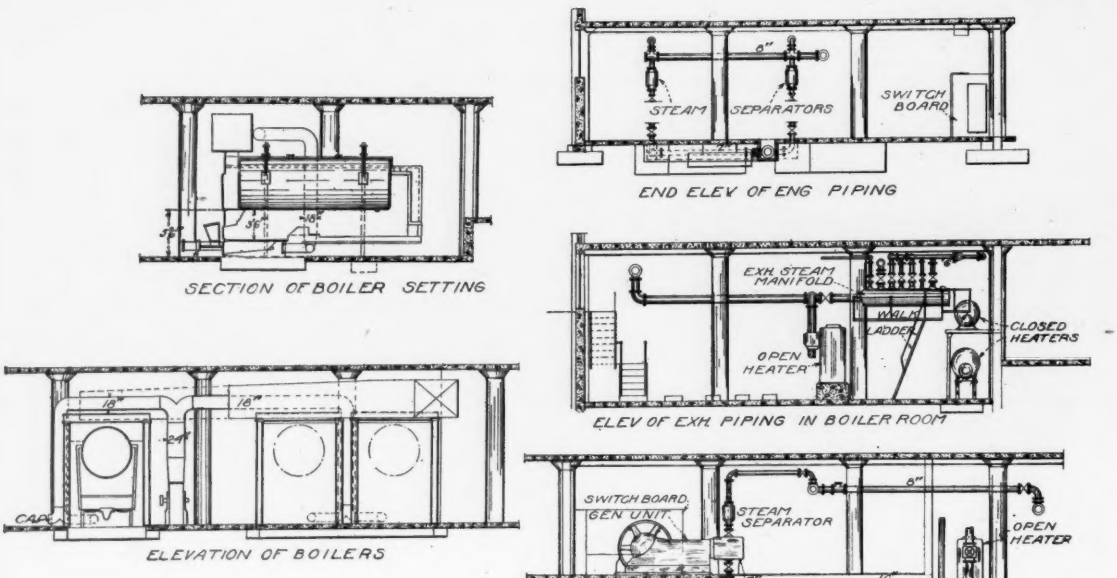


FIG. 3. ELEVATIONS AND PIPING DETAILS

boilers, however, is discharged direct to the sewer as the boilers are above the sewer level.

Hand control of the breeching dampers is employed, but this does not require frequent attention as the air to the furnace is automatically controlled by the draft fan. One breeching, increasing in size, serves all boilers and leads to the stack which is 5½ ft. in diameter and is 140 ft. high, which is considerably above the top of the building, giving ample draft for the present plant and all proposed additions.

Ashes are stored in a bin under the alley until a truck load has accumulated when they are shoveled into the boot of a Jeffrey bucket elevator and discharged into a truck for disposal. The elevator is driven by a 5-hp. motor.

For boiler feeding purposes make-up water is taken from the city mains and admitted through a float controlled valve into a 600-hp. Cookson heater which is of the open type, then delivered by McGowan simplex boiler feed pumps, 8 by 5½ by 12 in., of which there are two, through an Elliott twin strainer to the boilers. The temperature of the water as it enters the boilers is approximately 210 deg. F., being heated by exhaust steam from the engines and auxiliaries. The heater works on the induction plan and is provided with an oil separator and cut out valve. Although a back pressure valve is installed in the exhaust line to atmosphere it has not been found necessary to work the engine against a back pressure above the atmosphere.

In the boiler room are also two Sims closed heaters; one of these heats water for house lavatories and is 36 in. in diameter by 72 in. in length, contains 108 ft. of copper tubing and has 318 gal. storage space. The other, for industrial purposes about the factory, is 42 by 84 in., contains 252 ft. of copper tubing and has a storage capacity of 500 gal. These take exhaust steam from the exhaust steam expansion tank, the condensate drains to a Bundy trap and is delivered to the feed-water heater or during the season when the vacuum heating system is in operation the condensate is handled by the vacuum pumps. The temperatures are controlled by Weld regulators.

The Dunham system of vacuum heating is employed, all condensate is pumped by a McGowan simplex vacuum pump 6 by 8 by 12 in. to an air separating tank from which it drains back to the feed-water heater. All exhaust steam having passed through the oil separator on the heater before being used, the condensate is in good condition for boiler feeding purposes.

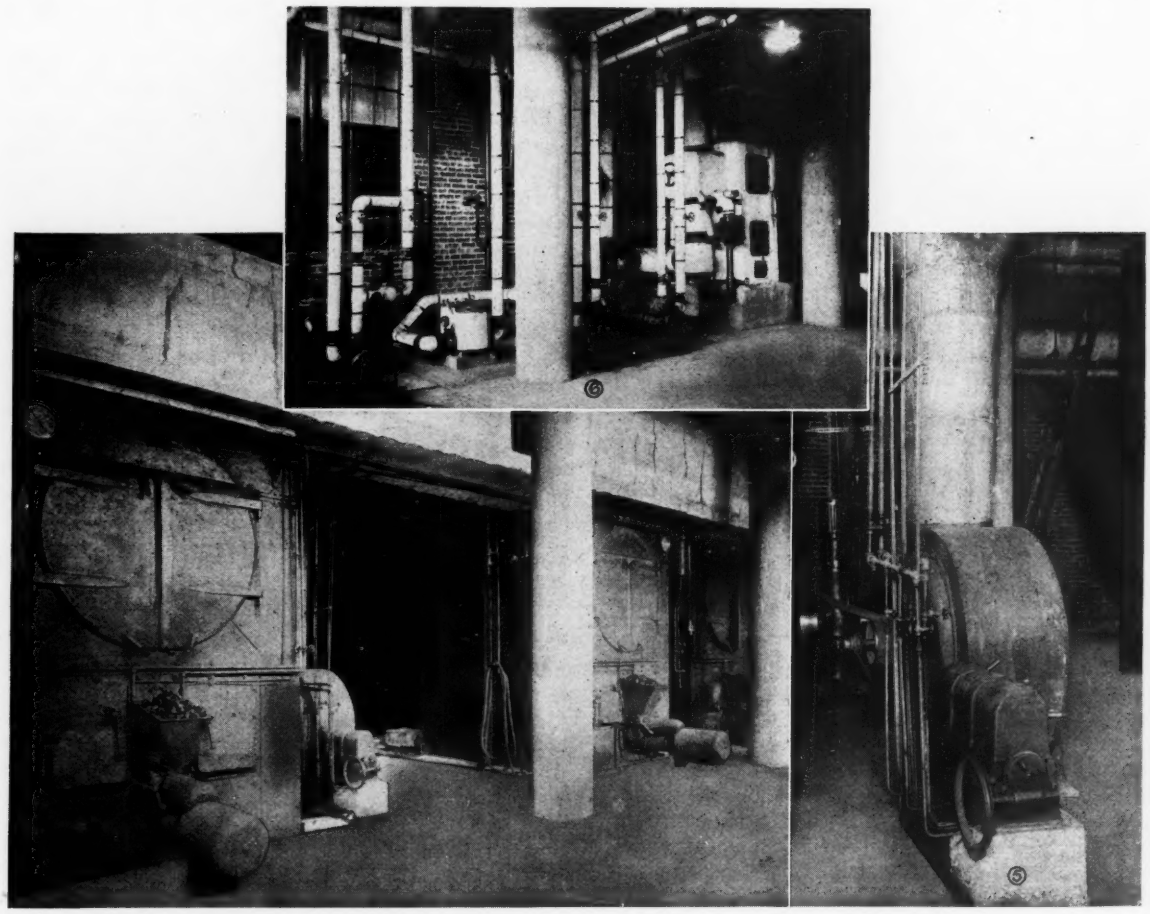


FIG. 4. BOILER ROOM SHOWING STOKER INSTALLATION
FIG. 5. STOKER TIMING DEVICE AND BLOWER EQUIPMENT

FIG. 6. VIEW IN BOILER ROOM SHOWING PUMPS AND HEATER

Compressed air for cleaning and industrial purposes, is supplied at 50 lb. pressure by a Westinghouse two-stage, size 10½ air compressor.

Generating Equipment

In the engine room are two generating units with provision for a third of the same size when load conditions demand. These are Ideal double eccentric non-releasing Corliss valve engines, 17 by 22 in., direct connected to General Electric Co., d.c. three-wire generators rated at 150 kw., 600 amp., 250 v., and run at 200 r.p.m.

Among the features of these engines which are noteworthy are the valve gear and the location of the valves. The steam valves are operated from the governor eccentric through a positive gear interposed between the eccentric rod and the valve stems. The gear box is bolted to the frame away from the heat of the cylinder, and the linkage is completely submerged in cool oil. The link motion in the gear box is so designed that the steam valves are given rapid travel during opening and closing for admission and cutoff, but remain practically stationary during expansion and exhaust. Exhaust valves are operated directly from a separate eccentric on the engine shaft.

Steam valves are of the Corliss design with double ports; exhaust valves have but single ports. Both sets of valves are located in the cylinder heads, an arrangement which materially cuts down clearance space and its detrimental effects upon steam economy.

The switchboard is made up of six panels consisting of two generator panels upon each of which are two ammeters, two circuit breakers, a voltmeter plug, and two single-pole single-throw switches, to which is attached the equalizer switch; one integrating voltmeter panel and three distributing panels. The voltmeter is mounted on a bracket at the end of the board.

The plant gageboard is located in the engine room and has mounted upon it Foxboro instruments for indicating pressure on the boilers, compressed air line, cold water piping, two hot water lines, three low-pressure steam lines, exhaust steam pressure, vacuum on heating system, and giving a graphic record of the steam pressure on the boiler.

For industrial heating processes, three low-pressure steam systems are provided, each receives steam from a header in the engine room through a reducing valve. The pressures maintained are 80, 60, and 28 lb. Drips and returns from the 60 and 28 lb. systems are handled by Anderson traps which deliver them to the feed-water heater. The 80 lb. line leads to the cotton plant about a block away and the condensate from this line is handled by a Cranetilt trap.

This plant has been designed by and installed under the direction of H. H. Morrison, consulting engineer of St. Louis, and operation is in charge of John Strom, chief engineer.

Selection of Engine Units

Factors to Be Considered and Methods of Procedure Towards a Logical Determination. By H. O'Neill

Determination of the size and number of engine units is an important problem in the design of a steam power plant. The question is a matter of cost and reliability. Where 24-hr. service is necessary, there must be reserve units to take care of possible shut-downs, and here a multiple unit plant would doubtless be advisable. For a uniform load such as is required by certain installations, the lowest cost of power will come from a layout of as few machines as possible; in a small plant, this may be a single machine. Under certain conditions, a variable load can be handled more cheaply with a multiple unit layout.

The principal advantage of a one-engine plant is its low first cost and consequent low capital charge per kilowatt-hour. If the load is fairly steady, the production charges may also be smaller than with a number of smaller units, each with a maximum efficiency lower than that of a single machine of their combined capacity.

Notwithstanding the present excellence of machinery, a one-engine plant is not reliable for continuous non-stop service. With such a plant, necessary repairs and inspection cannot be made without killing the entire power supply. A plant with several standardized units is unlikely to be shut down completely, and a stock of repair parts only slightly larger than for one machine is required. If the load is variable, ordinary repairs can be made during the lighter periods, while one or more machines are down, and often short peaks can be carried by overloading certain machines in order to withdraw an engine without shutting down the whole plant.

The purpose of the following analysis is to show how the cost of power with a variable load may be lower with a multiple unit plant than with a single unit plant, even at a higher first cost and lower rated efficiency.

Curve A, Fig. 1, shows a lighting load with a pronounced peak, but very low for over half the day. Allowing for possible increased demand, it is evident that a rated capacity of engine and generator of about 2500 kw. will be required. Clearly a 500-kw. machine could well supply power for 14 hr. and a 2000-kw. machine could take care of the peak. But the lack of standardization of units is disadvantageous and the reliability reserve is only 500 kw. The cost would be higher than that of a single 2500-kw. unit outfit and the latter would generally be preferable.

The problem is to compare the power costs of one 2500-kw. turbine outfit with the costs of a two 1250-kw. turbine plant. Curves in Fig. 2 show the variation of steam consumption with loads for the 2500-kw. turbine and those in Fig. 3 show the same characteristics of one and two 1250-kw. turbines. While the steam consumption of the larger machine at rating is about 5 lb. per kilowatt-hour better than the best steam consumption of the smaller unit, the efficiency of the larger machine is inferior at low loads. This lower efficiency at light loads is due to the fact that friction and other constant losses are greater for the large machine and conse-

quently the proportion of useful power to power supplied at light loads is smaller. It requires 17,000 lb. of steam per hour just to keep the big machine turning over without producing a single kilowatt, whereas it requires only 8800 lb. to overcome the no-load losses of the 1250-kw. machine. At loads less than 1250 kw., the small machine is more economical.

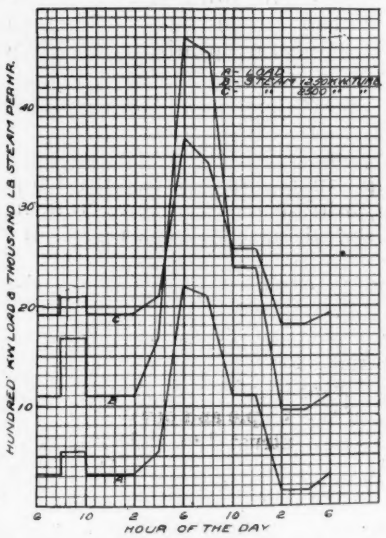


FIG. 1. LOAD AND STEAM DEMAND CURVES

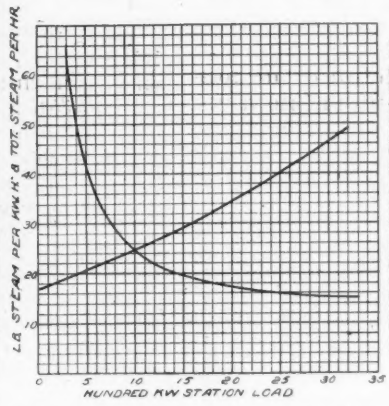


FIG. 2. TYPICAL WATER RATE CURVES FOR 2500-KW. TURBINE

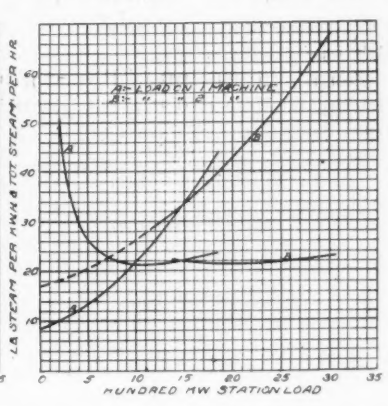


FIG. 3. TYPICAL WATER RATE CURVES FOR 1250-KW. TURBINE

Curves B and C, Fig. 1, show the respective steam demands of the one machine and the two machines supplying the load in curve A. On account of the low efficiency of the big machine at light loads, the two machine plant will require the less steam for by far the greater part of the time; however, the maximum steam demand of the two units is nearly 30 per cent greater than that of the single unit, and this may increase the boiler plant investment.

If the boilers are fired with natural draft, it is almost certain that the two-unit plant will have to be charged with additional boiler capacity; but with the flexibility of modern underfeed stokers, capable of great forcing, it is doubtful if a 30 per cent increase in maximum steam demand will require additional boiler equipment, and consequently the boiler plant cost is considered the same in either case. The steam production costs of the boilers operating 30 per cent higher will be higher and this must be charged to the two-unit plant.

Under certain pre-war conditions, the costs of power would be about as follows, as shown in Figs. 4 and 5:

ONE 2500-KW. MACHINE

Kw. load	500	1000	1500	2000	2500
Lb. steam per hr.	20,800	24,800	29,200	34,400	40,200
Cents total cost per kw.-hr.	1.68	0.901	0.646	0.528	0.462

TWO 1250-KW. MACHINES

Kw. load	500	1000	1500	2000	2500
Lb. steam per hr.	13,000	21,700	34,000	42,800	54,000
Cents total cost per kw.-hr.	1.49	0.872	0.711	0.61	0.57

By applying these costs to curve A, Fig. 1, we obtain the following costs for the respective plants:

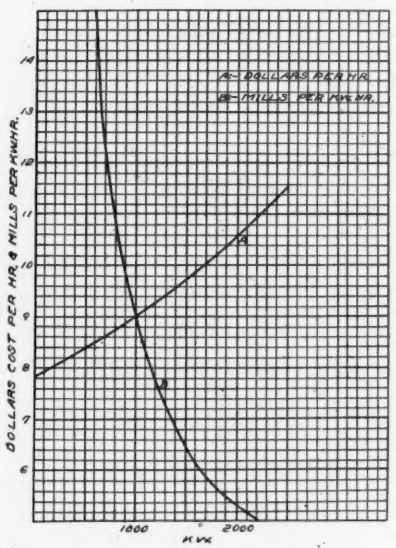


FIG. 4. POWER COST 2500-KW. PLANT HAVING ONE 2500-KW. MACHINE

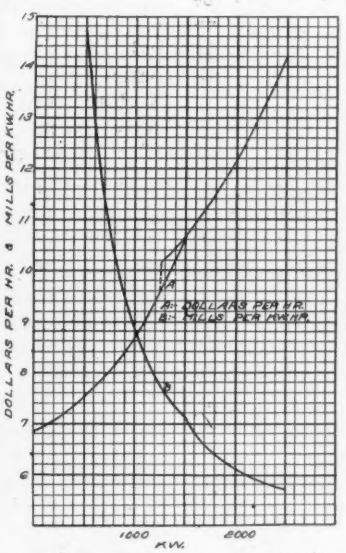


FIG. 5. POWER COST 2500-KW. PLANT HAVING TWO 1250-KW. MACHINES

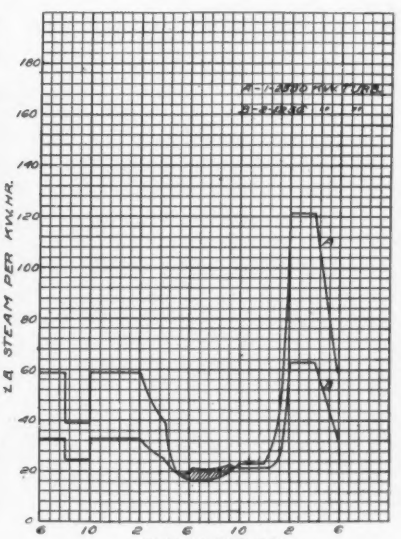


FIG. 6. VARIATION IN ENGINE EFFICIENCIES

	One 2500-kw. machine	Two 1250-kw. machines
Cost per day	$209.84	$202.36
Kw. hr. per day	18,360	18,360
Cost per kw.-hr	1.141c	1.102c

In every case it is necessary to analyze the particular requirements in order to arrive at a proper decision of the size and number of units.

Piping for Steam-Generating Plants

INSTALLATION AND OPERATION CONSIDERATIONS FROM A SAFETY POINT OF VIEW

OF THE accidents that occur in steam power plants, more originate from defective piping than from defective boilers, and yet comparatively little has been said or written about the safety aspect, in the designing and construction of piping. By "piping" we mean not only the pipes themselves, but also all fittings, valves, and other apparatus in connection therewith, such as separators, traps, and similar auxiliaries.

In designing and constructing piping for steam-generating plants, there are some general features common to the various classes which must not be overlooked if we hope to insure the highest degree of safety during operation. All pipes should be properly carried and supported—at the flanges if possible—and in such a way that they are left free to expand and contract without the production of severe stresses. The various pipe lines should also be anchored in such a way that strains from expansion and contraction do not occur at points where the pipes connect to the boilers, engines, or other apparatus, nor at or near the flanges or other connections in the pipes themselves. The anchorage points should be so selected that all expansion and contraction is taken up in the bends or in the expansion joints if such are provided; and each steam pipe should be given a slight downward inclination, or "fall," towards the draining points, so that no water can accumulate in it. Separate supports must also be provided for the different pipes, in such a way that one pipe line is not suspended from or supported by another one.

Pipes should never be sprung into position, and in order to reduce the number of joints, pipes should be used of the greatest length practicable. In turning an angle, steel pipes should be bent, whenever this is feasible, instead of using cast elbows or other fittings. All pipes, fittings, valves, and other apparatus in connection with the piping, should be of the best material of their respective kinds, and the design and workmanship should accord with the best standards, and be in conformity with the most modern approved practice.

Water in steam pipes is not only a source of danger, but also an indication of inferior design and arrangement of the piping system, and it may cause a great deal of unnecessary expense in the operation of the plant. It may be impossible to keep the pipe lines wholly free from water, but existing conditions can often be greatly improved so that the amount of water present will be materially reduced, and it is well worth while to take every precaution to effect such a reduction.

Water may gain admission to steam pipes in a number of different ways. The most obvious source, perhaps, is the condensation of steam that takes place in the pipes, on account of insufficient or improper insulation, or from admitting steam to cold pipes. Waste of heat on account of excessive condensation is an important factor in power plant economy.

Priming, which frequently results from forcing the boilers greatly beyond their rated capacity, causes moisture to be carried over with the steam into the pipes, and similar trouble may occur when using a poorly proportioned boiler having too small a steam space, even when it is operated under normal conditions. The presence of excessive quantities of alkali or organic matter in boilers often causes "foaming," which is similar to priming in many respects, and which also causes water to enter the steam pipes.

The chief danger from water in high-pressure steam piping, so far as the piping itself is concerned, is that due to water-hammer action. The shock thus produced may be great enough to fracture heavy pipes and fittings, and even if actual rupture does not occur, the vibrations that are produced in the pipe line are likely to loosen up the joints and cause other damage.

The importance of thoroughly draining steam-pipe lines before admitting steam to them cannot be overestimated, because many fatal accidents have resulted from the omission of this simple and obvious precaution; and this work should be intrusted to, and supervised by, a specially careful and competent man. The very simplicity of the operations that have to be performed may make an inexperienced or uninformed person skeptical of danger, and cause him to disregard the cautions that he has received. Moreover, the pipes may be air-bound so that some of the water will be retained in them after it has ceased to flow from the drain pipes and has apparently all been drawn off; and this is another reason why the work should be intrusted only to a cautious and experienced man.

The bypass valve (if one is provided) should first be opened when turning steam into a pipe, and the person manipulating the valve should be ready to close it immediately in case any unusual disturbance is noted, indicating the probable presence of water in the pipe. After the attendant has assured himself that the pipe is clear, he may open the main valve slowly and cautiously to its full extent.

Another extremely important precaution concerns the opening of valves of any considerable size, for the purpose of draining pipes that are already carrying steam, without first closing the steam-admission valves. Such action is quite likely to agitate the water so greatly that an accident will follow. If the water fails to run out after the steam valve has been closed it is likely that the pressure in the pipe is not sufficient to force the water through the drain. To overcome this difficulty the bypass valve (if one is provided) should be opened and a small amount of steam admitted to the pipe; or if there is no bypass the main valve may be "cracked" (or opened a bare trifle), and immediately closed again. It may be necessary to repeat this procedure a number of times before all of the water is expelled, and safety requires that the utmost care be observed during the entire operation.

It is easily possible to avoid the greater part of the trouble caused by the presence of water in steam pipes, by giving proper consideration to the design and installation of the boilers and the piping system. Care should be taken to provide a sufficient number of boilers to carry the load easily under normal conditions, and addi-

tional boilers should also be installed for emergency use, and in order that at least one boiler may always be shut down for cleaning. See that the boilers are properly proportioned as regards steam space, and that they have ample area for liberating the steam from the water. These features are essential to prevent priming. When priming is observed in a boiler that is already installed, the trouble may be lessened to some extent by connecting a dry-steam pipe to the steam outlet, on the inside of the boiler. This pipe should be slotted or perforated on top, so that steam may enter it freely while water cannot gain entrance so readily; and the combined area of all of the openings should be at least twice as great as the area of the steam-supply nozzle. A drip should be provided at the lowest point in the dry pipe, to drain off the water that accumulates in it.

The piping should be erected, if possible, in such a way as to avoid low places (called traps or pockets) where water may collect. Drain pipes of ample capacity should be provided wherever such pockets cannot be avoided, and also at points where risers are connected. Where small branch pipes are connected with steam mains by reducing tees, in such a way that the steam flows from the main into the branch pipes, and also when taper reducers are used, drips should be connected at the lowest points. A stop valve should preferably not be located in a vertical steam pipe (particularly in a branch pipe from a boiler to a steam main), because when a valve of this kind is closed water will collect over the valve seat—frequently in considerable quantities. This water may be removed by means of a drain pipe tapped into the body of the valve just above the valve seat, but with such an arrangement there is always the possibility that the attendant may neglect to open the drain valve before opening the steam valve, and in an event of this kind an accident is quite likely to occur. If a valve must be placed in a vertical pipe, it is better practice to connect the drip to a trap, so that the pipe will be drained automatically.

Steam pipes should be installed with a uniform grade of about 1 in. in 40 ft., so that any water that may be present will drain away. Engineers differ as to which way a pipe should slope, however. Some prefer it to drain back toward the boiler, while others maintain that it should drain away from the boiler, so that the water and the steam will flow in the same direction. If the pipe is made to drain away from the boiler, provision should be made at suitable points for thoroughly removing any water it may contain, and the drips should be connected to traps. All branch pipes should likewise be installed on a grade. If they are of large size, or if they can be shut off from the main pipe by means of valves, they should have separate drains.

So far as practicable, the drip pipes should be connected to a common main which in turn is connected to an automatic steam trap. (This principle does not hold true, however, in cases where there are two stop valves in a branch pipe connecting a boiler and a steam main. With such an arrangement a drain pipe should be tapped into the branch pipe at some convenient point between the two valves. The other end of this drain pipe should be left open, and should be in such a location as to be visible to the operator while he is opening the drain valve.) The steam trap discharges the water of condensation into a receiving tank or hot well, and from this it may be pumped back to the boilers or utilized in other ways. Each drip pipe should be provided with a stop valve, and also with a check valve located between the stop valve and the trap. Individual traps should be provided where the drips are a considerable distance apart, because otherwise there may be sufficient difference in pressure to cause the water to back up from one drip pipe into another.

In arranging a drainage system it is important to provide at the outset for the maximum demands that may be made upon it, because an inadequate system is a source of endless annoyance and trouble. The amount of water that collects as the result of condensation when steam is admitted to a cold pipe line is far greater than that which is present under normal operating conditions, and yet it is important that it should be disposed of quickly. The presence of excessive organic matter in the boilers may cause them to foam, and forcing the boilers for the purpose of carrying overloads may induce priming as previously suggested; and if either foaming or priming takes place extra demands will be made upon the drainage system, and trouble is likely to result if such emergencies have not been foreseen and provided for. An experienced and competent engineer should be consulted when designing and installing steam-pipe lines, and by following his advice many difficulties will be avoided in the operation of them.

Separators and superheaters are widely used to prevent water from gaining entrance to turbines and to the cylinders of reciprocating engines, where it is likely to cause damage. The efficiency of all types of steam engines is greater when they are supplied with dry steam, and for this reason alone it is well worth while to install separators in plants where the steam is ordinarily wet. Moreover, metallic surfaces are frequently damaged by the cutting action of moist steam, as is often shown by score marks on the pistons, cylinder walls, and valves of reciprocating engines. Turbine blades are also affected in a similar way, so that frequent renewals are necessary if the steam contains any considerable amount of moisture. It is hardly necessary to state that all separators must be provided with drain pipes of ample size. Superheaters are widely used in large steam plants, especially in connection with turbines; and where a good superheater is properly installed the trouble from water in the mains is materially reduced, because free moisture cannot exist in superheated steam. In starting up a cold engine or turbine, however, the same precautions should be used whether the superheater is present or not; and it should not be forgotten that when the superheater is located at a considerable distance from the engine or turbine, the superheat may be entirely lost by radiation from the pipe, so that condensation can occur, with the attendant precipitation of water.

In order to secure the best results when using a separator, the separator should be located as near the engine cylinder as possible, because if there is any considerable length of pipe between the two there will be opportunity for further condensation, and the steam will again become moist. It is also desirable to have a separator of large size, or of the "receiver" type, because in this way a steam-storage reservoir is pro-

vided which insures greater uniformity of pressure in the engine cylinder up to the point of cutoff, and overcomes in large measure the vibrations in the steam piping due to the interruptions of the flow of steam from the regular and frequent opening and closing of the engine valves. If a receiver is used, however, it should be well protected by a good covering of some effective heat-insulator, because otherwise there will be a considerable waste of heat by radiation from its surface.—The Travelers' Standard.

Power Plant Instruments as an Investment---VII

ADVANTAGES TO BE GAINED FROM THE USE OF STEAM ENGINE INDICATOR. BY M. A. SALLER

THE steam engine indicator can be considered as an absolute necessity in every plant where a reciprocating engine is in service because this instrument shows graphically the performance of the steam in the engine cylinder and makes possible a check on the efficiency of the very important stage of power generation where the steam is being converted into useful work, and where the possibilities for loss are numerous and of serious proportions.

The more general uses to which the indicator is put, and which serve to make any investment in this equipment exceedingly profitable, are:

(1) Determining whether the valves of the engine are set properly to secure the best possible steam economy under prevailing conditions of load and steam pressure.

(2) Determining the amount of power developed in the engine cylinder, i.e., the indicated horsepower.

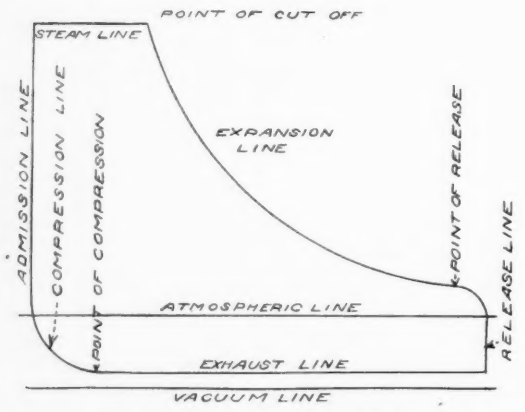


FIG. 1. PERFECT STEAM ENGINE INDICATOR DIAGRAM, SHOWING THE IDEAL SET OF CONDITIONS THAT SHOULD BE STRIVEN FOR

(3) To ascertain drop in steam pressure between the boiler and engine, through the valve chest or port openings, etc.

(4) Determining whether excessive cylinder condensation is taking place and whether there is steam leakage around the steam valves or piston.

(5) Offers a check for preventing the carrying of an excessive amount of back pressure.

(6) Makes possible a determination of the friction load in the shafting, etc.

Taking up the first point, the indicator card shows very clearly whether or not the valves of the engine are set for the best possible steam economy. It is not infrequently the case that a re-adjustment of the valves of an engine in accordance with information supplied by the indicator will reduce the steam consumption from 10 to 20 per cent, and in extreme cases even more. Recently in connection with a 1200-hp. condensing engine, which had been running over a year without checking up the valve setting, a half hour's work with the indicator, which led to advancing slightly the eccentrics operating the valves, caused an increase of about 9 per cent in the capacity of the engine—a saving that netted over $500 in a single month.

Too frequently the valves of an engine are set by the marks placed on the valves by the manufacturer; but these markings at best serve only as guides for the approximate location of the valves, the finer adjustment made possible by the use of the indicator being necessary

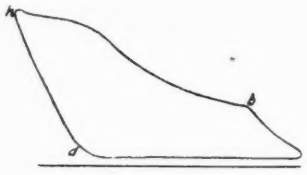


FIG. 2

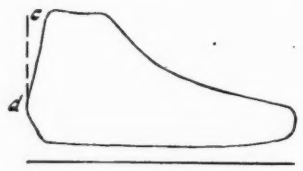


FIG 3

FIG. 2. INDICATOR CARD SHOWING THE EFFECT OF TOO EARLY ADMISSION OF THE STEAM TO THE CYLINDER

FIG. 3. INDICATOR CARD SHOWING EFFECT OF TOO LATE ADMISSION

from time to time to take care of the wear on the valves, connecting mechanism, etc.

In checking up the horsepower of the engine, the indicator is also of great value. The indicator will show whether the load is being properly distributed between the two sides of the piston. One engineer imagined his engine to be greatly overloaded when as a matter of fact only the head end of the cylinder was overloaded, because due to improper valve adjustment it was carrying almost 70 per cent of the load. After distributing the load evenly over the two ends of the cylinder, the engine ran smoothly and without knocking.

The amount of power developed is also necessary in order accurately to establish power costs, etc. Especially

where a number of units are in service the horsepower records of the engines enables the operator so to adjust the load that the engines can be loaded up to the point where they operate at the best economy. In a plant running five small engines, it might be possible during times of light load to throw all the load on two or three engines, causing them to yield the most economical power rather than running all five units at light and inefficient loads.

The matter of drop in pressure in steam lines and through the valve chest has also an important bearing on over-all economy, and the indicator is very useful in checking this undesirable pressure drop. One plant showed a drop in pressure between the boiler and engine of 12 lb., due to restricted and tortuous piping. By placing a receiver ahead of the engine, the drop in

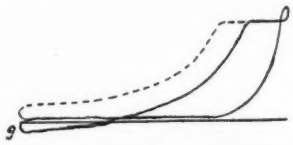


FIG. 4. INDICATOR CARD SHOWING THE EFFECT OF CUTTING OFF THE SUPPLY OF STEAM TOO EARLY. THE STEAM EXPANDS UNTIL ITS PRESSURE IS LESS THAN THE BACK PRESSURE, AND THE EXPANSION LINE CROSSES THE BACK PRESSURE LINE TO FORM THE LOOP "G." THE LOOP AT THE TOP OF THIS DIAGRAM ALSO INDICATES THE RESULT OF TOO EARLY COMPRESSION—THE STEAM BEING COMPRESSED IN THE CLEARANCE SPACE UNTIL THE PRESSURE RISES ABOVE THAT IN THE STEAM CHEST

pressure was cut down to 2 lb.—the increase in pressure available at the engine reducing the steam consumption of the unit by over 1 lb. of steam per horsepower hour. Assuming a steam cost of say 30 cents per 1000 lb., the saving on a 250-hp. engine running 10 hr. a day would amount to $225 a year of 300 days. On a 1000-hp. engine the saving would mount to $900.

Leakage past the engine valves due to wear and ill adjustment, and poor fitting, frequently causes a loss in engine efficiency and capacity, and leakage also often takes place around the piston because of loose or broken

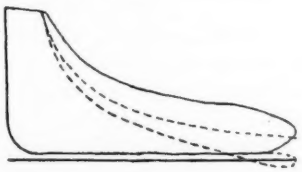


FIG. 7. EFFECT ON THE INDICATOR DIAGRAM OF STEAM ENTERING THE CYLINDER THROUGH A LEAKY VALVE. IF THE EXPANSION LINE IS NOTICEABLY ABOVE THE THEORETICAL ADIABATIC EXPANSION LINE (AS SHOWN) IT IS A SIGN THAT STEAM ENTERS THE CYLINDER THROUGH A LEAKY VALVE AFTER CUT-OFF. IF THE EXPANSION LINE FALLS BELOW THE THEORETICAL LINE, STEAM LEAKS PAST THE PISTON, OR GETS OUT THROUGH A LEAKY EXHAUST VALVE

snap rings. The indicator diagram will show up these conditions and hence give the engineer the opportunity of correcting them.

Excessive condensation of steam in the cylinder is also shown up by the indicator diagram. Excessive cylinder condensation is indicated on the diagram when the expansion line falls below the theoretical adiabatic line at the beginning of the stroke and then crosses over again (see illustration). Excessive cylinder condensation in one plant, shown up by the indicator card, was eliminated by the installation of a good steam separator and the lagging of the valve chest and cylinder with a heavy coating of asbestos. The saving in this case amounted to about 15 per cent, *i. e.*, the steam consumption of the engine was reduced to that extent.

Exhausting against a back pressure also cuts down the capacity of the engine, and the study of the indicator card often points the way for cutting down the amount of back pressure and thus increasing capacity or cutting down steam consumption. A 500-hp. engine taking steam at 100 lb. pressure, having a normal steam consump-

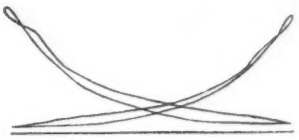


FIG 5

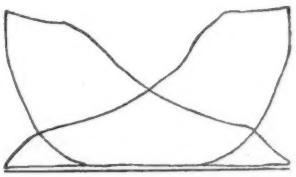


FIG 6

FIGS. 5 AND 6. DIAGRAMS TAKEN FROM A HIGH SPEED SINGLE VALVE AUTOMATIC ENGINE, SHOWING THE ENGINE UNDER WORKING LOAD (FIG. 6), AND SHOWING IN FIG. 5 THE "FRICTION LOAD," TAKEN WHEN THE ENGINE IS RUNNING WITHOUT LOAD, SHOWING THE WORK DONE IN OVERCOMING THE FRICTION IN THE BEARINGS AND SHAFTING

tion of 30 lb. of steam per horsepower-hour when exhausting free to atmosphere, has its steam consumption increased to about 34.8 lb. when exhausting against 5 lb. back pressure. Figuring steam at say 25 cents a

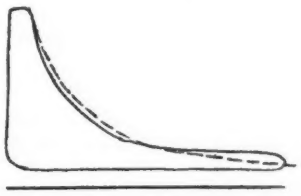


FIG. 8. INDICATOR CARD SHOWING THE EFFECT OF CONDENSATION AND RE-EVAPORATION IN THE CYLINDER. IF THE EXPANSION CURVE FALLS BELOW THE THEORETICAL ADIABATIC LINE AT THE BEGINNING OF THE STROKE, CROSSES AND THEN GOES ABOVE, IT IS AN INDICATION THAT EXCESSIVE CONDENSATION OCCURS AT THE BEGINNING OF THE STROKE, AND THEN RE-EVAPORATION TAKES PLACE AT THE END. SUPERHEATED STEAM AND PROPER LAGGING OF THE PIPING AND STEAM CHEST SHOULD REMEDY THIS TROUBLE

1000 lb. and with the engine running 10 hr. a day, the cost of carrying this back pressure would amount to $1200 a year. If the indicator would lead to cutting

down this cost by only 1 lb. of back pressure or even less, the saving would certainly be worth while.

By taking indicator cards with the engine carrying free shafting load, and then taking cards with the engine running free, the difference in power consumed can be established as the friction load in the shafting, belting, etc. Frequently this test will show a surprisingly large loss of power in friction load in the shafting, etc., which can be reduced by proper alinement of the shaft, proper lubrication, etc.

As an investment, the indicator will point the way to possible savings or prevent losses from creeping in far in excess of the price of the instrument; it pays, therefore, to have an indicator in the plant and use it frequently and regularly.

Watch Your Step!

By Walter N. Polakov

DURING the last quarter century much has been done and said in the field of industrial management and the managerial mechanism developed proved, beyond doubt, that it is nothing but a mechanism and as such may or may not produce the desired results depending on how and by whom this mechanism is used.

The management of power plants drags on the tail of the procession probably for two reasons:

1st. Because of the fallacy that good equipment necessarily produces good results.

2d. Because financial interests consider the cost of power an insignificant item of the total expense.

Now, when we feel the pinch of the shortage of fuel and when this shortage not only enhances the cost of power but endangers the very existence of various industries, even the health and well-being of communities, these fallacies must be disposed of at once.

It is not the equipment and supplies that produce results but the mode of their use. When this is realized two problems present themselves to power engineers:

1st. To secure mechanism for modern management and,

2. To make proper use of it.

Securing of managerial mechanism involves the assuming of responsibility by the plant owners, since it is obviously their task to provide the plant with the means to study the causes and effects, to standardize the best practice and to keep adequate and dependable records.

Securing the result of the mechanism involves the education and training of the employes to make proper use of the available knowledge. Furthermore, they must have permanent and sufficient incentive for learning the better way, taught them by an enlightened management, and living up to it. Under such conditions, the executive is relieved of all the worries as to routine details, as these are standardized and can be well taken care of by subordinates. The major part of the time of the executive may thus be devoted to solving special problems and to furthering the improvements of the managerial mechanism and its working.

The results accomplished in the plants which have adopted these principles are permanent, since they are worked out from the bottom up and economy accomplished varies all the way from 15 to 50 per cent, depending upon the shape in which the plant was originally found.

To meet the present contingency both as to men and fuel, the first thing to do is to put the house in order after a thorough study so that the methods may be based on facts, not on opinions and traditions. When this is done, room will be found to build up the efficiency.

Failure to manage your own plant may be augmented by purchasing power from an outside source, thus allowing others to do your thinking. That this does, however, not pay, is evident by the accompanying diagram illustrating a typical case by which it was found possible

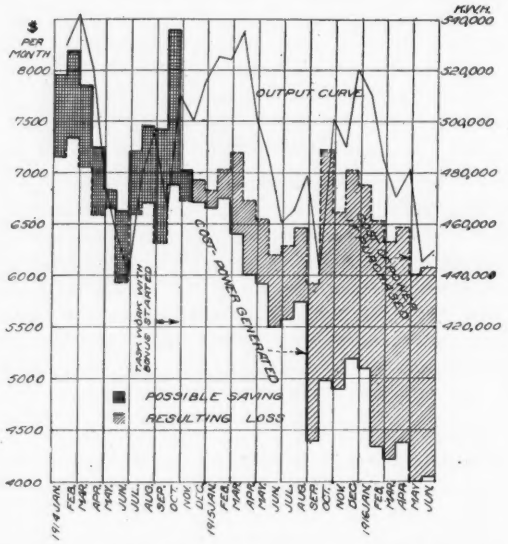
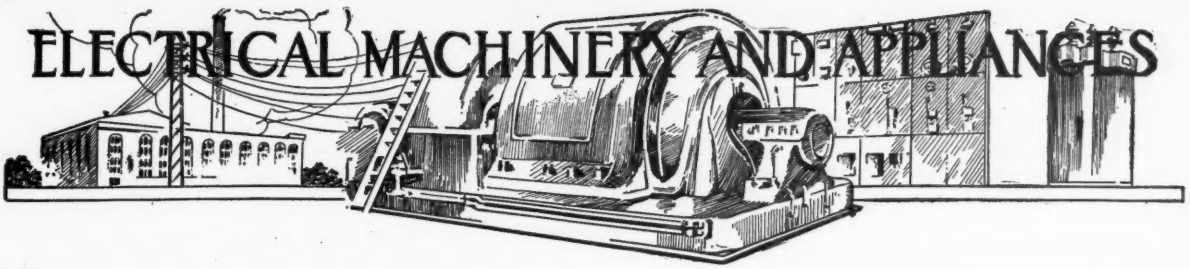


DIAGRAM SHOWING RELATIVE OPERATING COSTS BEFORE AND AFTER INTRODUCTION OF SCIENTIFIC MANAGEMENT

by the introduction of scientific management to operate at a materially lower figure than was possible to purchase the service from a well-known public utility company.

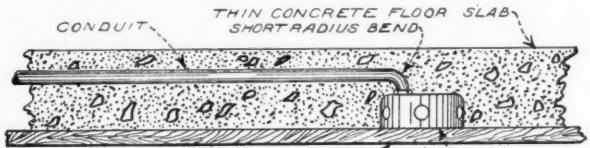
As an indication of the preparations which are being made in France, an ordnance base is being established to take care of the equipment of the army in France, to cost $25,000,000. This will include 20 large storehouses, 12 shop buildings, 100 smaller shops and magazines, and machine tool equipment to cost about $5,000,000. The gun repair plant will be able to reline more than 800 guns a month; the motor vehicle repair plant to overhaul 1200 vehicles per month; the small arms plant to repair 58,000 small arms and machine guns a month, and the reloading plant to reload about 100,000 artillery cartridge cases per day. To maintain this plant will require about 450 officers and 16,000 men, of which some 8000 had been enlisted up to the first of January. This service gives an opportunity for men of special training, who are not able to serve in the ranks, to be of aid to the army. Information in regard to enlistment can be had at any recruiting station.

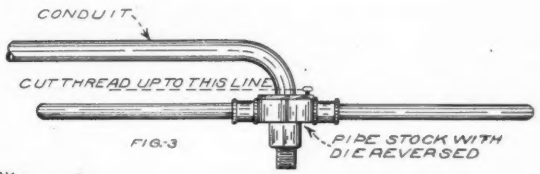


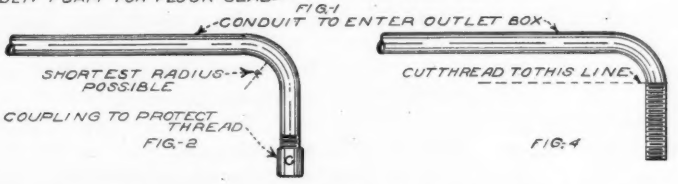
Method of Making Short Radius End Bends in Conduit

By Martin S. Hamilton

IN MAKING short-radius end bends such as may be required where an elbow enters an outlet box as shown in Fig. 1, special methods must be adopted. Such bends differ from ordinary short-radius bends in that they must be threaded. These are frequently required in thin concrete floor slabs when it is desirable that the conduit enter the bottom of the box as shown in Fig. 1. The feature that necessitates unusual handling is that the bent end of the tube must be threaded. The first step is shown completed in Fig. 2. The bend of the short radius, R, has been formed, the coupling, C, having been turned on the threaded end of the tube to prevent the mutilation of the threads during the bending process. The bend at R should ordinarily be of the shortest radius







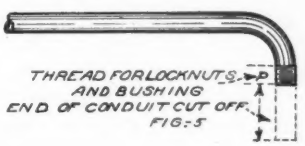


FIG. 1. SHOWING HOW A SHORT RADIUS BEND IS NECESSARY IN A THIN FLOOR SLAB WHEN CONDUIT FEEDS INTO OUTLET BOX FROM THE TOP

FIG. 2. COMPLETION OF FIRST OPERATION IN FORMING SHORT RADIUS BEND FOR OUTLET BOX

FIG. 3. CUTTING THREAD ON CONDUIT END WITH DIE REVERSED

FIG. 4. CONDUIT END THREADED UP TO BEND

FIG. 5. CONDUIT END CUT OFF AND READY FOR INSERTION IN OUTLET BOX

which it is possible to make. Next, the die in the pipe stock is reversed in its socket (Fig. 3) and the end of the tube is then threaded as far as it is possible to turn the die on the pipe. The end thus threaded appears as shown in Fig. 4. Now the surplus length (Fig. 5) is cut from the end, so that the threaded portion, P, which remains, is merely long enough to accommodate the locknut, the bottom of the outlet box and the bushing. After assembling, the bend appears as delineated in Fig. 1.

IN INDUSTRIAL plants, where the advantages of efficiency, ruggedness and permanency of reflecting surfaces are important, porcelain-enameled light reflectors may be used to advantage.

Carbon Brush Troubles

THEIR CAUSES AND REMEDIES

IN A paper presented before the Association of Iron and Steel Electrical Engineers at its annual convention at Philadelphia, E. H. Martindale gave some of the causes of carbon brush troubles and the remedies to be used.

Causes and remedies for sparking at brushes are:

1. Brushes off electrical neutral—Shift to neutral by trial or set on neutral by means of voltmeter.

2. Brushes spanning too many bars—Trim down faces of brushes to obtain proper thickness or, if holders are clamp type, use thinner brushes.

3. Brush studs not parallel with the commutator bars—Bend the brush studs or grind or shim under the bolts which fasten the studs to the yoke until stud is parallel with segments.

4. Incorrect brush spacing—Check the spacing by counting the number of bars between studs or by placing a strip of paper around the commutator with divisions marked off equal to the number of studs, and correct spacing by rotating the brush studs or the brush holders on the studs.

5. Brushes tight in brush holders—Clean the holders with gasoline, and if brushes are still tight, sandpaper them down or file out the holders carefully.

6. Brush pressure too low—Pressure should be 1.75 to 1.5 lb. per square inch cross-section for stationary motors and generators, 2.5 to 4 lb. for elevator and mill motors, 3 to 5 lb. for crane motors, 4 to 7 lb. for railway motors.

7. Too low contact drop of brush—Consult a brush manufacturer.

8. Insufficient abrasive action of brushes—Use a commutator stone or more abrasive brushes.

9. High mica—Use abrasive brushes, a commutator stone or undercut the mica.

10. Poor adjustment of interpoles—Consult the manufacturer of the machine.

11. Overloads—Undercut the mica, use low-friction brushes and check up all causes for short-circuit currents.

12. Open circuit in armature coil—Rewind that part of the armature or make temporary repairs at commutator.

13. Loose connection at commutator—Scrape and resolder all defective connections.

14. Worn bearings—Shim or renew the bearings.

15. Unequal air gaps—Shim the short poles or grind off the faces of the long poles, or if form worn bearings, see paragraph 14.

16. Short-circuit currents between brush studs caused by unbalanced armature winding—Consult the manufacturer of the machine.

17. Eccentric commutator on high-speed machine—Turn or grind down to true surface.

18. Poor belt lacing—Relace, or, still better, use an endless belt.

19. Pounding of reciprocating engine driving the machine.

20. Unstable foundation.

21. Cross-currents between generators operated in parallel driven by reciprocating engines due to variation in angular speed of engines—Use heavier flywheel.

Causes and remedies of flat spots on the commutator are:

1. Any form of sparking.

2. High bars—Tighten the commutator bolts and turn or grind down the commutator.

3. Low bars—Tighten the commutator bolts and turn or grind the commutator.

4. Eccentric commutator on high-speed machine causing the brush to jump from the commutator at the high spots—Turn or grind the commutator.

5. Surges of load current due to short circuit on the line or an instantaneous high-peak load.

6. Mechanically unbalanced armature—Place on balancing ways and add weight at lightest point.

7. Difference in hardness of commutator bars—Undercut the mica and use non-abrasive brushes.

8. Difference in hardness of mica—Undercut the mica and use non-abrasive brushes.

Causes and remedies for blackening of the commutator are:

1. Sparking.

2. Too much lubricant in brushes or used on commutator—Clean commutator with gasoline.

Causes and remedies of a direct-current motor or generator heating are:

1. Severe sparking.

2. Short-circuit currents.

2a. Brushes off neutral.

2b. Faulty brush spacing.

2c. Too thick brushes.

2d. Unequal air gaps.

2e. Crooked brush studs.

2f. Too low contact drop of brushes.

2g. Unbalanced armature winding.

3. Too high or too low brush pressure.

4. High-friction brushes—Undercut mica and use low friction brushes.

5. Commutator too small—Consult the manufacturer of the machine.

6. Too high a ratio of brush area to commutator surface—Use fewer brushes of higher carrying capacity and lower friction.

7. Chattering of brushes.

Causes and remedy of pitting or honey-combing of brush faces are:

1. Short-circuit current.

2. Too low brush pressure.

3. Brushes of insufficient carrying capacity—Consult a brush manufacturer.

Causes and remedies for the brushes picking up copper are:

1. Sand under the brush faces—Wipe brush face carefully after sandpapering either brushes or commutator.

2. Commutator not thoroughly cleaned after turning—Finish the surface with a commutator stone.

3. Collection of copper dust by lubricant in abrasive brushes—Undercut the mica and use non-abrasive brushes.

4. Electrolytic action—Change the grade of brush; better consult a brush manufacturer.

Causes and remedies for brushes chattering are:

1. High-friction brushes—Change the grade of brushes or pressure.

2. Rough commutator—Use a commutator stone.

3. Dirty commutator—Clean with gasoline.

4. High mica—Use a commutator stone or undercut mica.

5. Wide slots between bars with thin brushes—Fill the slots with commutator cement.

6. High bars—Tighten the commutator bolts and turn or grind the commutator.

7. Flat spots—Use commutator stone unless the flat spots are too large for stoning, in which case turn or grind the commutator.

8. Brush operating at the wrong bevel, frequently found where brushes are operating in a stubbing position with angles of less than 20 deg.—Change the grade of brush or angle of operation. Better consult a brush manufacturer or the manufacturer of the machine.

Loosening of brush shunts is caused by:

1. Poor workmanship in attaching shunts.

2. Insufficient carrying capacity—Consult a brush manufacturer.

3. Heating.

4. Vibration.

5. Combination of heating and vibration.

6. Loose terminal screws causing unequal distribution of load.

7. Unequal brush pressure causing unequal distribution of load—See that all brush pressures are uniform.

8. Heavy short-circuit currents between different brushes.—N. E. L. A. Bulletin.

Motor Drive for Pumping Service

PRACTICAL METHOD OF SELECTING A CENTRIFUGAL PUMP FOR ANY CONDITION OF CAPACITY AND HEAD. M. W. EHRLICH.*

THE motor driven centrifugal pump as a unit for the many pumping services in commercial and industrial buildings, and as an auxiliary in power plants is destined to wider use. The 10 to 15 yr. successful application of this pump to a variety of conditions, shows that it is capable of such services as have heretofore been considered in the field of the reciprocating pump only.

Wrong notions and improper designs originally gave ground for the erroneous theory that a centrifugal pump would serve only against very low heads. This, however, has all been corrected. The modern centrifugal pump of the single-stage type may be found in daily service, delivering against a head of as great as 150 ft. in some cases. The multiple stage unit is likewise delivering its capacity for different services against heads of 500 ft. and over,—and this at a pressure of more than 200 lb. per square inch.

Actual performances, then, show that under many different conditions and for various services, the centrifugal pump is commercially suitable for pumping moderate and large quantities of water against almost any practical head and at reasonable efficiencies.

The features in favor of this unit are the small floor space it occupies, its relatively low first cost, and the

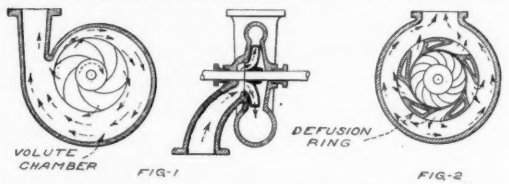


FIG. 1. CENTRIFUGAL PUMP WITH VOLUTE CASING
FIG. 2. TURBINE TYPE CENTRIFUGAL PUMP

negligible maintenance and repair charge. For a capacity of 200 gal. a minute an efficiency of 50 per cent may be expected, this factor increasing gradually with the larger sizes to about 70 per cent average for 3000 gal. In the smaller sizes, that is, those of capacities less than 150 gal. a minute, the efficiency falls off rapidly, requiring the use of a relatively large motor.

In commercial designs that are on the market, distinctive construction details distinguish one make from another. In selecting a centrifugal pump, there is, therefore, little choice as to style when high-grade apparatus is under consideration, all having about the same operating efficiency. In general these pumps may be grouped into two classes—the "volute" and the "turbine" types, each virtually named according to the style of casing, which is of spiral shape for the volute and circular for the turbine pumps. The chief distinction, however, is that in the volute pump a whirlpool chamber is provided, as shown, while in the turbine type diffusion vanes are employed, through which the water must pass in each case.

These pumps are furnished with either open or enclosed style impellers, and for the larger size pumps, impellers with a double water entrance are usually provided. This provision is mainly a construction feature for the maintenance of commercial efficiency and pumps so equipped are designated as "double-suction" centrifugals. This also makes it possible to use two suction inlets, when desirable, though commonly one connection is employed.

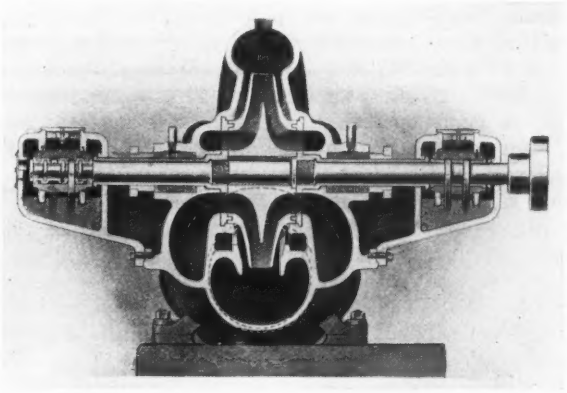


FIG. 3. TYPICAL SINGLE STAGE, DOUBLE SUCTION CENTRIFUGAL PUMP

The main feature from the engineer's viewpoint is the selection of an adequate driving unit to handle properly the service conditions. With this also falls the lot of deciding on the pump, as the two go to make up a complete unit, either direct-connected or through gearing.

It is important, therefore, to understand that a single stage centrifugal pump is economically suitable for

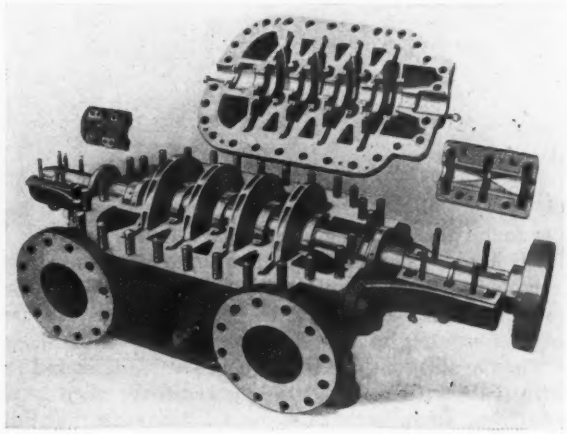


FIG. 4. TYPICAL FOUR STAGE CENTRIFUGAL PUMP

pumping against a total head of 100 to 150 ft. Because of the differences on this point, however, in the various makes, it is sound judgment to limit the head to 130 ft. for a single stage centrifugal. If higher working heads are required, a multistage pump should be employed. This style of centrifugal is in effect several single pumps,

*All rights reserved.

on one shaft, connected to operate in series and enclosed in a single casing. The arrangement is such that the discharge from one impeller becomes the suction of the next, so that the working head becomes a direct multiple of the number of stages employed.

To aid in the selection of a suitable centrifugal pumping unit, the chart printed in the Practical Reference Tables of this issue has been prepared. It gives, by direct reading, a complete specification of what the unit should consist, if it is to fulfill a given service condition.

Consider a case where 260 gal. of water must be delivered in a minute. Say this has to be pumped against a pressure of 15 lb. per square inch and that the source of water supply is some distance away, necessitating the use of a horizontal run of pipe. Now, then, 15 lb. times 2.3 gives 34.5 ft. and the pipe friction represents, say, 5.5 ft., giving a total head of 40 ft. against which the pump must operate.

The service condition then is 260 gal. a minute, against a total head of 40 ft. What should be the features of the pumping unit for this combination?

Referring to the scale of line A to the left of the chart, 260 gal. is found to require a pump larger than 3 in., but less than 4 in. The larger size is the one to select unless the particular manufacturer favored with the orders happens to build a 3½-in. pump. For the head of 40 ft. on the scale of line B at the right, it is seen that a single stage centrifugal will suffice. Then laying a rule or straightedge across, to connect the two values as determined by the service conditions, that is, connecting 260 and 40 as shown, gives an intersection on the scale of line C, at 5 hp., which is the size of the motor required.

In this simple manner it was determined that for a service of 260 gal. and a 40-ft. head, a 4-in. single stage pump with a 5-hp. motor is required.

The same method applies for any other pumping service. Consider a centrifugal boiler feed pump for a power station. The number of gallons a minute for a 15,000-hp. boiler installation would be about 900. If the steam pressure is 150 lb. per square inch, the head would equal 345 ft., but to this must be added friction and other losses, especially if the water is forced through the coils of a feed-water heater. The total head may then be, say, 375 ft. What should be the pump unit for this condition?

Reading directly from the chart on scale A, it is seen that for 900 gal. a 6-in. pump is required. Then on scale B is found that the pump must have four stages for a 375-ft. head. Connecting the two known points with a straightedge, gives an intersection at about 138 hp. for the motor size. Of course, the nearest commercial size motor of say 150 hp. would be selected.

Then again, consider that a house water tank 150 ft. above the basement of a building has to be filled by a centrifugal pump in that basement. Assuming that this is the total head and that 350 gal. a minute must be supplied, what combination of pumping unit must be used to meet the conditions? By direct reading of the chart this is found to be a 4-in., two-stage centrifugal, driven by a 25-hp. motor.

The size of a pump as here given, is based on the delivery of the unit at its rated capacity, which commercially corresponds to the diameter of the discharge nozzle. The horsepower requirements given by the chart for any combination of service embodies that variable component,—Efficiency, and it also corresponds to the rated capacity. In plotting these values for convenient solution of centrifugal pump installation problems, considerable data were collected and analyzed, so that the results show what should be expected commercially.

What Will Your Liberty Bond Do?

YOU are, of course, planning to buy bonds of the Third Liberty Loan, and it will be of interest to know what Uncle Sam can accomplish with the money you lend him.

For a $50 bond, he can buy 10 cases of surgical instruments for officers' belts, or 37 cases for soldiers' belts, or 14 rifle grenades, or 23 hand grenades, or trench knives for a rifle company.

For a $100 bond he can clothe a soldier, or feed one for 8 mo., or buy 5 rifles, or 145 hot water bags for hospitals, or 2000 surgical needles.

For a $100 and a $50 bond, he can equip a soldier for overseas service, or feed one for a year.

For two $100 bonds he can buy a horse or mule for cavalry or artillery service.

Three $100 bonds will buy a motorcycle for a machine-gun company.

And a $500 bond will supply bicycles for the headquarters company of an infantry regiment.

Inspectors for Ordnance

THE BRANCH OFFICE of the Inspection Division, Ordnance Department, 600 West Jackson Boulevard, Chicago, has immediate need for 250 to 300 inspectors. At the present time, positions of inspector of field artillery ammunition and inspector of carriage division are open. Both these positions pay a salary of $3.50 to $5 for an 8-hr. day and time and one-half overtime. These positions are in the vicinity of Chicago. It is anticipated that many more examinations will be opened up immediately. Female applicants between the ages of 21 and 50, male applicants between the ages of 32 and 50, will be considered.

Applicants are especially needed who have had artillery ammunition, carriage, motor, small arms or small arms ammunition experience. There is immediate need for the services of these inspectors and applicants are requested to report to Mr. Becker, 600 West Jackson Boulevard, Chicago, Ill., for interview and application blank.

Prices for Lignite Coal at the Mines in Texas

MAXIMUM PRICES governing the sale of lignite coal in the mines of Texas have been announced by the United States Fuel Administration.

Texas lignite prices, as fixed in an order of the Fuel Administration confirming the order of the Federal fuel administrator for Texas, and made effective as of March 5, are as follows:

Run of mine, $1.40; screened lignite, with at least 15 per cent of screenings taken out, $1.50; screenings, 85 cents.

Preparing for Future Demands

INDIANAPOLIS LIGHT & HEAT CO. GUARDS AGAINST POSSIBLE FUTURE FUEL SHORTAGE BY INSTALLING MAMMOTH SUBMERGED COAL STORAGE PIT

DURING THE FUEL CRISIS through which this country just passed, the authorities in charge of the distribution of coal bent every effort possible toward providing an adequate and continuous supply to all householders and those industries vital to the welfare of the people and essential to the prosecution of the war. Central power stations serving such industries and supplying steam for the heating of homes and manufacturing establishments naturally were included in the list of preferentials, and as a consequence, the majority of them suffered no complete shut-down. Spite of this, however, the situation proved extremely acute and except in a few isolated instances resolved itself into a hand to mouth proposition.

Consumers of coal will, however, in the future not only strain every effort toward the economical use and the conservation of fuel, but will, where able to do so, provide ways and means to have on hand a sufficient supply of coal to tide them over any periods of general shortage which in the future may arise. One of the larger of the middle west central station companies which has already taken the initial steps to insure against possible shut-down or curtailment of service on account of lack of fuel is the Indianapolis Light & Heat Co., of Indianapolis, Ind., which has included in the power station being constructed at Kentucky Ave. and Mill St., a mammoth out-of-door, underground submerged coal storage pit which, together with the coal and ash handling system to be installed, embodies a number of unique and interesting features.

The plant now under course of construction will be located on a plot of ground adjoining that occupied by one of the company's two existing stations which, while furnishing electric energy, is primarily employed as a steam heating service station. Except for a 4000-kv.a. General Electric bleeder turbine placed in operation about 18 mo. ago, the engine room equipment is more or less obsolete, and although the vertical engines installed are fitted with condensers, these are employed only during the non-heating season. At other times, the steam from the engines, together with that bled from the various stages of the turbine, exhausts directly into the heating mains, the average pressure in which is maintained at about 6 lb. gage; during severely cold weather, this may reach a maximum value of from 12 to 14 lb.

FIG. 1. GENERAL VIEW OF COAL STORAGE PIT

THE NEW PLANT

WHILE PLANS call for a station the ultimate arrangement of which will be as indicated in Fig. 4, the only work being done on the project at present is the building

of an out-of-door underground, submerged coal storage pit and the erection of a section of the new boiler house.

A view of the coal storage bin as it appeared during the early part of March is shown in Fig. 1. Of reinforced concrete construction and with the portion of one wall built integral with the turbine room wall foundation, the structure has an overall length of 145 ft., an overall width of 69 ft. 3 in., and an internal depth of approximately 30 ft.; it is designed to provide storage space for 12,000 tons of coal sufficient according to present demands, to carry the load throughout an entire

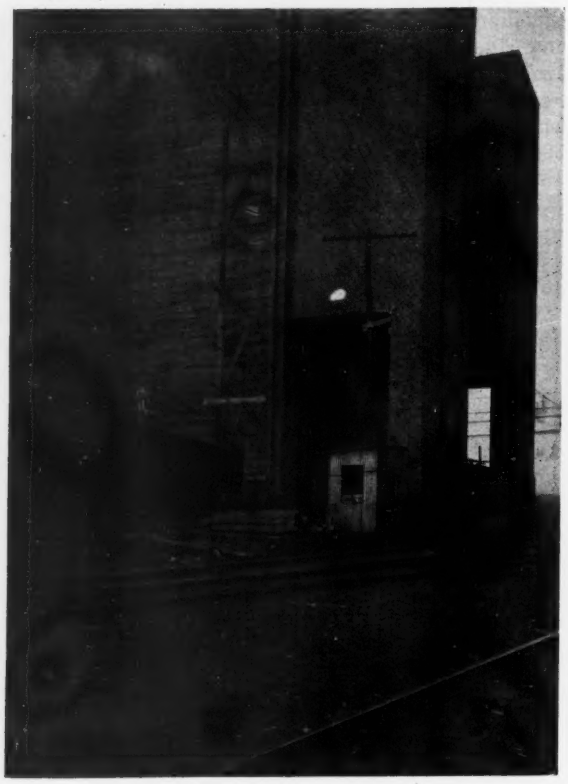


FIG. 2. COAL AND ASH HANDLING TOWERS

heating season. Side and end walls, the former provided with supporting pilasters, have thicknesses of 2 ft. 6 in. and 3 ft. respectively, and in order to add to the stability of the structure and as an aid in removing the coal, the lower portion of the walls are sloped inward to such an angle as to give them a footing thickness of 9 ft. 6 in., except the wall adjoining the turbine room, along which this thickness has been reduced to 7 ft.

Coal will be delivered in dump bottom cars run on standard gage tracks laid on I-beams spanning the pit and supported in the center by a reinforced concrete pier as shown in Figs. 1 and 4. For the removal of the coal there will be shortly installed an electrically operated crane and grab bucket, the former to ride on tracks supported by structural steel work on each side of the pit, and in order to facilitate its transfer to the bunkers in the boiler house, the coal will be discharged by the grab bucket into the buckets of a conveyor at the bottom of a receiving pocket located at one corner of the pit. From here, as indicated in Fig. 4, it will be carried through a tunnel under the turbine room floor and dumped into a motor driven crusher below the boiler house basement floor, there to be reduced to the size required. A cross conveyor will then transfer it to the buckets of the main elevating conveyor which in turn will raise it to the bunkers above.

Coal for immediate consumption is to be delivered in bottom dump cars to the opposite end of the plant for discharge into receiving hoppers located at the bottom of the towers illustrated in Fig. 2. The path of the travel of the coal from this point to the bunkers will be the same as that coming from the storage pit.

The cross conveyor previously mentioned will be used primarily for the handling of the ashes. As these leave the stokers, they will fall into concrete firebrick-lined hoppers through the gates of which they will discharge into the buckets of this conveyor and by means of this will be transferred to either one of the two elevating conveyors by which they will be deposited in the hoppers occupying the upper section of the towers shown in Fig. 2. Each of these hoppers has a capacity of 200 tons and by means of hand operated valves provided for the purpose may be emptied of its contents into the cars below. In fact, as soon as one car has been cleared of coal and its dump sides replaced, it may at once be filled with ashes and in that manner much unnecessary switching eliminated.

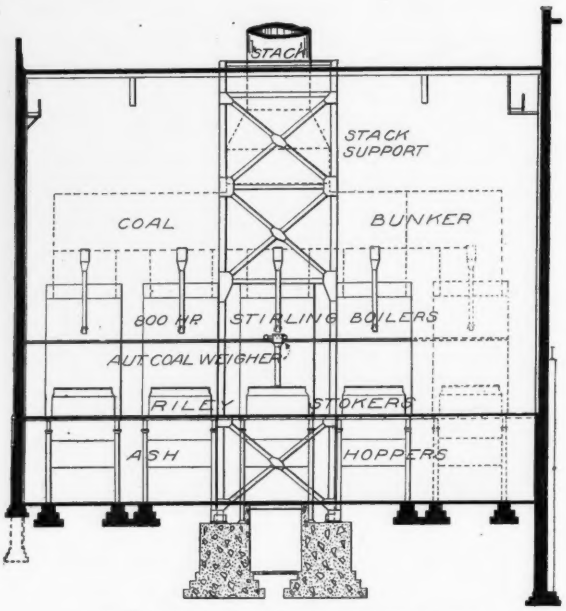


FIG. 3. SECTION OF NEW BOILER HOUSE

Should at any time the ash conveying system become inoperative, due to accident or otherwise, the stoker hoppers may be emptied by discharging the ashes directly into trucks driven beneath them.

STEAM GENERATING EQUIPMENT

THAT PORTION of the boiler room already erected is of steel, concrete and red brick construction and has over all dimensions of 116 ft. 3 in. by 124 ft. 6 in. exclusive of the coal and ash towers, which add 19 ft. 10 in. to the

length of the structure. Concrete foundation walls resting on piles carry the weight of the building and for the support of the boilers there have been provided concrete columns reinforced with heavy I-beams and heavy concrete stack bases of the form shown in Fig. 4.

At the present time, there are being installed five 800 hp. Stirling water-tube boilers equipped with Riley under-feed stokers and Foster superheaters and although no additional steam generating units are to be installed within the immediate future, provision has been made to allow the placing of a second row of units of like size directly back of these. And to provide for sufficient capacity to meet possible future load demands, ultimate plans call for an extension to the boiler house which would allow the installation of seven rows of like units or a total of 35 boilers.

The various rows of boilers will be placed back to back and as may be seen by referring to Fig. 4 showing foundation plans, each row will be provided with an individual self supporting brick stack 14 ft. in diameter and 270 ft. high.

Ordinarily steam will be maintained at a pressure of 250 lb., but superheated to a temperature 200 deg. F. in excess of that corresponding to this pressure.

Between the rows of boilers and near the roof of the boiler house will be erected steel bunkers of such size as to furnish a storage capacity of 200 tons per boiler. From here, as shown in Fig. 3 the coal will be fed through chutes discharging into an automatic weigher mounted on trucks running on tracks carried parallel to the boiler fronts. One of these weighers will be provided for each five units and will enable the operator to determine the exact amount of fuel used by each boiler.

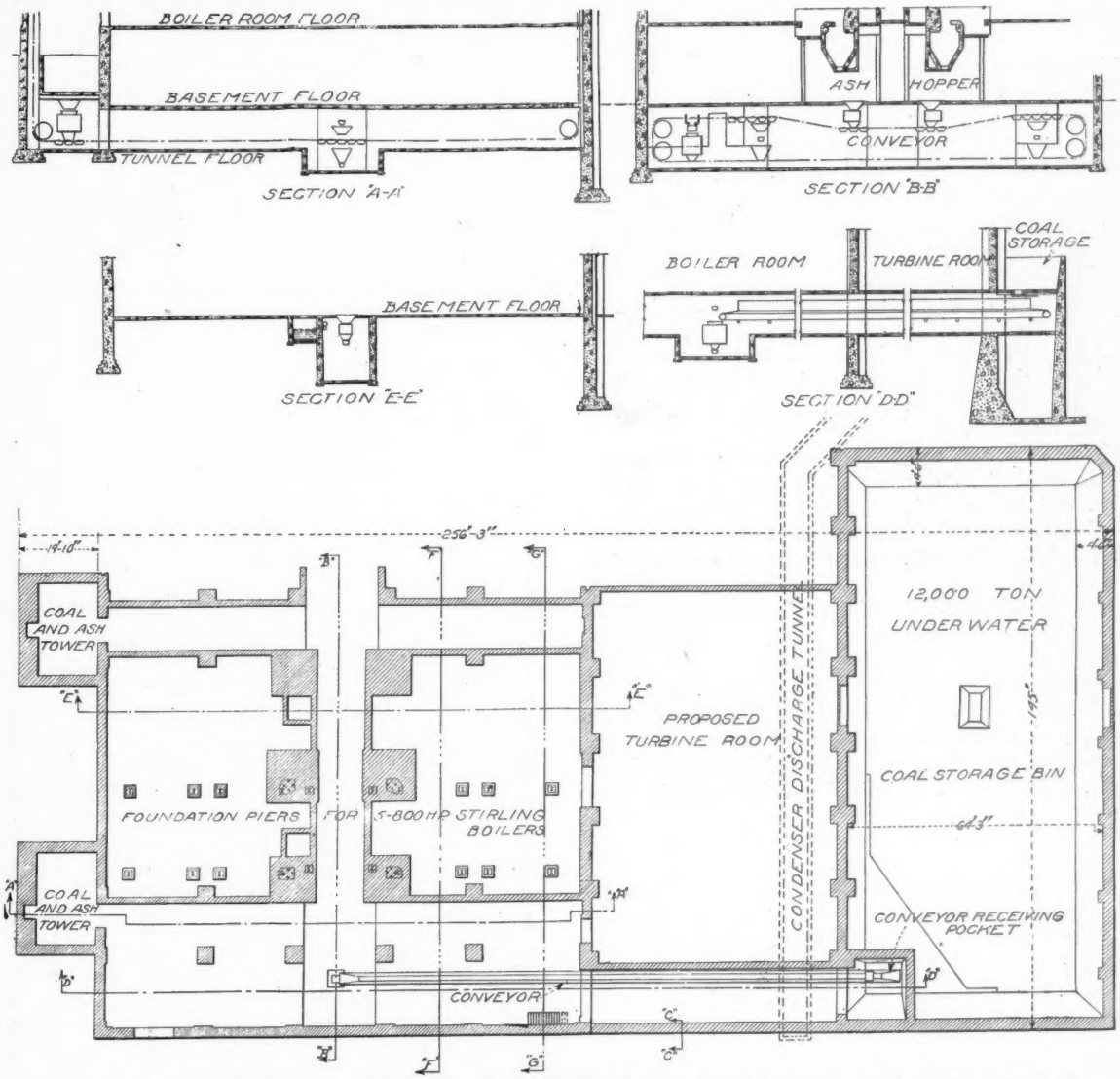


FIG. 4. PLAN SHOWING NEW BOILER HOUSE, PROPOSED TURBINE ROOM AND COAL STORAGE PIT; ALSO FUEL CONVEYOR DETAILS

New Turbine Room Equipment

At present, no further work will be done in connection with the turbine room, as it is the desire of

those in charge to postpone this until such a time as increased electrical load will warrant the necessary expenditures. When, however, this part of the station is completed, it will, according to present plans, contain five 20,000-kv.a. units with sufficient additional floor space to care for seven generating sets of this size.

Suggestions for Pipe Insulation

WHEN using 85 per cent magnesia covering for piping systems, the following suggestions will be found useful and to give good results. Standard thicknesses are as follows:

For pipe ½ to 1½ in., use covering ⅞ in. thick.
For pipe 2 to 3½ in., use covering $1^1/_{16}$ in. thick.
For pipe 4 to 6 in., use covering 1⅛ in. thick.
For pipe 7 to 10 in., use covering 1¼ in. thick.
For pipe 12 in. and larger, use covering 1½ in. thick.

Pipe covering is in sections 3 ft. long and blocks are 3 by 18, 3 by 36, 6 by 18 and 6 by 36 in., and should be of uniform thickness.

For boiler tops or drums the blocks should be 2 in. thick, finished with 1 in. of plastic magnesia, making a total of 3 in. Ends of drums should be covered with blocks wired in place, covered with plastic and with a canvas jacket outside; total thickness 3 in., beveled around manholes.

Where brick side walls of boiler settings are covered, a wire or V-rib netting should be securely fastened by bolts, and covered with 2 in. of block or plastic, all openings for doors being beveled. It is best to protect the insulation for 4 ft. from the floor by a sheet iron casing.

For breechings, use ½-in. mesh iron wire cloth set out by V-iron to give an air space, and cover as for boiler tops.

For piping carrying superheated steam, cover with 1½ in. thick sectional covering, wired in place with No. 18 iron wire. Then apply a second layer of the same, spaced to break butt and lateral joints and wire in place. Finish with ½ in. of plastic magnesia, cover with rosin sheathing paper and a jacket of 8-oz. canvas sewed on, 3 stitches to the inch. Fittings should be covered with blocks and plastic to a thickness of at least 2½ in., finished smooth by troweling and with a canvas jacket. Flanges should have a 2-in. insulation of plastic made up in halves on a ½-in. mesh wire framework so as to be easily removed and replaced. A canvas jacket should be used on the outside. At flange bolts, the covering should be beveled to allow removal of bolts without injuring covering.

Drips for superheated steam should have 1½ in. of sectional covering wired in place and finished with ½ in. of plastic and canvas jacket over sheathing paper. Fittings should be covered with 2 in. of plastic and canvas jacket and flanges with 2 in. of blocks and plastic with canvas jacket.

For saturated steam at pressures over 150 lb., a double 1½-in. covering should be used, all joints filled with plastic and finished with canvas jacket. Drip pipes covered with a single 1½-in. covering, and fittings and flanges the same as for superheated steam.

For pressures 100 to 150 lb. use a double covering of standard thickness for the pipe size in question applied as above. Fittings and flanges covered to a thickness of 2 in.

For pressures under 100 lb. use a single covering of standard thickness with pasted jacket, and bands 18 in. apart. Cover flanges and fittings to same thickness as pipe with blocks and plastic finished with canvas jacket.

Boiler feed and exhaust piping are covered the same as for steam under 100 lb. except that large exhaust mains may be covered with block or plastic 1½ in. thick and finished with a coat of hard finish cement. Heating mains in tunnels should be covered like large exhaust mains.

For outdoor piping, insulation should be used as for pressures 100 to 150 lb., but finished with 3-ply waterproof roofing applied with lapped joints and secured by bands of No. 16 copper wire, 8 in. on centers.

Heaters, tanks, etc., should have a covering of blocks and plastic 1½ in. thick or more, depending on steam pressure as for piping.

Hot and cold air ducts and fan casings should have a covering 1 in. thick secured by No. 18 galvanized iron wire, all cracks pointed up with plastic and exposed edges protected with a light metal angle corner.

For appearance, all insulation should be covered with 8-oz. canvas over rosined paper, neatly sewed 3 stitches to the inch, and in exposed positions, the canvas should be thoroughly sized and given two coats of standard lead and oil paint.

$50

BANG! A German shell comes crashing upon an American trench. A dozen of our boys fall bleeding into the mud. Up rush the stretcher bearers. "Thank Heaven," says the lieutenant, "for the $50 bond which that fireman in Cleveland bought. The serum which he paid for will keep 139 of us safe from lock jaw."

Back the stretchers hurry to the first aid dressing station. As the busy nurses reach for first aid packets, one of them says, "That's the 160th we've used this morning. And they all came from that $50 bond that the oiler in Memphis paid for last April. I wonder if he knows how many lives he has saved?"

In the field hospital the surgeons are busy removing shell splinters, setting broken bones and closing great gashes. "Got enough ether?" asks the major. "Sure," replies the captain. "That engineer who purchased a $50 bond in St. Louis furnished us enough to use for 400 painless operations. He ought to think of that every time he skins a knuckle."

Out in No Man's Land the soldiers are lying in the hot sun in shell holes. Water is scarce and some of them drink a little from the muddy pools. "We should worry," says the corporal. "That $50 bond that the switch-board man in St. Paul bought is keeping 666 of us huskies safe from typhoid here on the firing line. And smallpox; why the $50 from the record clerk in Chicago has made 1000 of us immune."

Men of the power plants, do you realize what $50 will do for the men of the trenches? Is your $50 on the way to help save their lives?

Some Tables That Are Misleading

TEMPERATURES AND PRESSURES OF AMMONIA GAS DO NOT FOLLOW SATURATED CONDITIONS IN AMMONIA COMPRESSORS. BY A. G. SOLOMON.

THERE IS a table found in textbooks and catalogs that is very misleading if it is taken just as it appears and not studied out. It gives pressures and the corresponding temperatures, but it must be remembered that these given temperatures are seldom found in actual practice. Those who operate plants entirely by the gages and not by thermometers will find that problems figured out do not give the proper results.

The table to which I refer is the one giving the number of cubic feet of gas that must be pumped per minute at different suction and condenser pressures to produce one ton of refrigeration in 24 hr. The suction and condenser pressures are given and also the saturated temperature of the ammonia at the different pressures.

This is all very well as far as it goes. It is a table figured out theoretically, but such conditions are seldom, if ever, found in the practical operation of refrigerating machinery.

The ammonia discharged from the compressor is never at the temperature corresponding to the pressure except in very rare cases, and then only for short periods at a time. This is readily understood if we take the two types of compressors and consider them.

The so-called dry gas compressors are furnished with water jackets, to take away the heat of compression. These water jackets only partly perform the service for which they are intended. The water cannot take away all the heat generated, consequently the gas leaves the compressor at a much higher temperature than that for saturation. This discharge temperature varies with the degree of saturation at which the vapor reaches the suction valve. "Reaches the suction valve" is the expression used instead of reaches the cylinder, for the reason that in nearly all cases the ammonia changes from the saturated to the superheated state when passing through this valve. The valve ports and disc are in contact with the high temperature gas during part of the time, and this tends to heat them; so the temperature and, therefore, the weight of gas entering the compressor depends on the degree of saturation at which it reaches the suction valve, the construction of the valve and the temperature of the parts of the valve and surrounding metal.

The ammonia is not saturated after it enters the cylinder, and, therefore, not at the saturated temperature either at the end of the suction stroke or when discharged to the condenser. The re-expansion of the hot, high pressure gas, which fills the clearance space, will also help to evaporate any liquid which comes from the coils of the low pressure side of the system.

So with the dry gas compressor, as it is operated in ordinary practice, the temperature of the discharged gas is not governed entirely by the pressure. The temperature can be anything up to or even higher than 250 deg., with a condenser pressure of 185 lb.

Then we see that the volume and weight of the ammonia gas discharged depends more on the temperature than on the pressure.

In the humid or wet gas compressor, liquid ammonia is allowed to enter the cylinder to take up the heat of compression. Even when liquid injection is used, the vapor does not remain in a saturated state after entering the cylinder. The heat of the cylinder walls, heads, piston and piston rod will evaporate whatever liquid is contained in the ammonia and after this vaporization the vapor will become superheated in that it will approach the temperature of the metal.

But with the humid gas compressor and the liquid injection it is possible to regulate the discharge temperature so as to have the gas temperature be that of saturated vapor at the condenser pressure. This way or regulating the discharge temperature does not increase the efficiency of the machine as the exact proper amount of liquid injection cannot be admitted to suit the changing conditions. It will increase the capacity of the condenser as liquefaction will take place sooner.

Now we see that the only way to use this table correctly is to know the actual temperature of the vapor when it enters the cylinder at the end of the suction stroke and at the end of the discharge stroke. To get these temperatures right, it will be necessary to use recording thermometers in all places.

Take for example a dry gas compressor, operating on 15.25 lb. back pressure and 182.6 lb. condenser pressure. This back pressure gives an ammonia temperature of zero, and the condenser pressure corresponds to a temperature of 95 deg. (Ammonia tables by Goodenough and Mosher.)

We will assume that the vapor reaches the suction valve at the zero temperature, and that it is discharged into the condenser at 200 deg., which is the condition found most common in ordinary everyday practice with the dry gas compressor.

This 200-deg. temperature will necessarily heat up the cylinder walls and all other parts which come in contact with the hot gas. With such conditions it is impossible to expect the ammonia to be saturated after it passes through the suction valve and enters the cylinder. It does not remain saturated. The amount of superheat will vary under changing conditions, such as speed of machine, temperature and amount of jacket water and area of the compressor valves. Just what the temperature and weight of the vapor will be at the end of the suction stroke can only be determined by actual test and thermometer readings; but, according to data obtained, it is safe to say that this temperature is never lower than 50 deg. It is often much higher, in some rare cases reaching 100 deg.

Now, how much ammonia is actually handled by the compressor? It cannot be the amount that it would be if the ammonia remained in the saturated state throughout admission, compression and discharge.

Looking at the table referred to, we see that at 16 lb. suction, and 184 lb. condenser pressure, the pumping of 3.83 cu. ft. of gas a minute is required to produce one ton refrigeration in 24 hr. These pressures correspond to a temperature of zero and 95 deg. respectively.

Looking at the ammonia table, we find that at a temperature of zero a cubic foot of saturated vapor weighs 0.1089 lb. The 3.83 cu. ft. will amount to 3.83 × 0.1089, or 0.417,087 lb. This rate a minute will in an hour equal about 25 lb.

Now, in actual practice, the temperature of the ammonia in the cylinder at the end of the suction stroke will be taken as 50 deg. instead of zero. At the same pressure as before, we find that the ammonia now occupies 10.41 cu. ft. to the pound. The 3.83 cu. ft. will weigh 0.3679 lb. In an hour 22.074 lb. will be pumped. This is a difference of about 3 lb. per hour for each ton refrigeration capacity of compressor cylinder. In large installations this will amount to considerable. By this example, we see that the greater the degree of superheat the greater must be the cubic feet displacement of the compressor to produce a ton refrigerating effect.

Figuring the actual capacity of a refrigerating machine by any set rule, and using constants given in the tables, is about impossible. The operating conditions must all be considered regarding temperatures, even more than pressures. Indicator cards are also necessary to get the actual displacement. Take any ammonia cylinder of known dimensions. The cubical contents in inches or feet is easily found, but that does not mean that the full volume of the cylinder is pumped at each stroke. The clearance can also be measured, so that it will be known to the smallest fraction of a cubic inch. But, even when we know the exact clearance, we do not know how much of the cylinder is occupied by the re-expansion of the ammonia.

The indicator is absolutely necessary to determine the volume of ammonia gas pumped. Thermometers are just as necessary to tell us the state or condition of the ammonia.

The manufacturers of ice machines make a compressor of a certain diameter and stroke to run at such a speed to produce so many tons of refrigeration in 24 hr. But they also say that the machine will do the work under certain conditions. These conditions are sometimes found, but not by any means in the majority of cases. To get the rated capacity from a compressor, the only way to do is to keep the machine and all other apparatus in first-class condition, and then regulate the whole plant in such a way as to approach, as nearly as possible, the proper conditions.

Temperature and amount of condensing water are two factors over which we have only limited control. The same capacity must not be expected from two plants identical in construction if the one has 60 deg. water and the other has the same amount of water, but at a temperature of 85 deg.

The actual amount of ammonia which can be evaporated in a plant depends entirely on the weight of the ammonia that can be sent to the condensers. This amount is not entirely dependent on the size of the ammonia compressor, but also on the temperature, and, therefore, weight of the gas. The closer this gas can be kept to a saturated state, the greater will be the capacity of the entire plant, and the smaller the cost per horsepower per ton.

Regarding Ammonia

THE Food Administration sends out the following suggestions as to saving ammonia:

Before starting your plant in the spring (or if it is now operating) see to it that the ammonia system is perfectly tight. The slightest smell of ammonia indicates a leak which should be located and stopped at once.

Small leaks may be detected by burning sulphur in their presence.

Leaks in condensers or tanks may be traced by the use of Phenolphthalein testing paper, which can be obtained from your ammonia dealer.

Test for leaks daily and be on the lookout for them continuously!

See that the pump or compressor rods are true and properly alined, and that the stuffing boxes are properly packed with good packing.

Stuffing boxes are the source of heavy losses. When subjected to extreme changes in temperature they must be carefully adjusted and lubricated to prevent leakage or heating. Packings of proper design and material correct stuffing box troubles.

Another source of leak is the pitting or roughening of infrequently used valve stems (particularly those that are exposed to moisture) tearing the packing when they are opened or closed. This can be prevented by smoothing up the valve stems and keeping the exposed part of the stem covered with a heavy grease.

Care should be taken in the manipulation of expansion valves so as not to force liquid ammonia to the compressor; it will start leaks and may cause accidents.

Do not pump a vacuum on ammonia system unless absolutely necessary, as a vacuum tends to draw air into the system. No vacuum is necessary when charging ammonia into the system. When it is found necessary to purge the system of air, or other noncondensible gases, shut off and cool down the condenser or absorber to be purged. Do not blow direct to the atmosphere when purging but carry the purge line close to the bottom of a receptacle containing slowly running water. Purge slowly! Noncondensible gases are indicated by bubbles rising to the surface, while a crackling sound indicates the loss of ammonia.

Your own interest demands that you get every employe interested in this campaign. There is no better way to get them interested than to offer them a share of what they save.

The Food Administration urges you to give a bonus, in a manner similar to that outlined below, and to put it promptly before your employes. The savings may be computed by finding the difference in fractions of a pound of ammonia used per ton ice in 1917 and 1918. This difference times the tons of ice made in 1918 gives the total saving of ammonia in pounds, and pounds saved multiplied by cost price of ammonia gives the saving in dollars and cents.

The employes' share should be agreed upon when the campaign starts. It may be any part of the entire saving, but for this campaign 50 per cent is recommended.

Initial charges for plants started in 1917 or losses due to accidents should not be considered as ammonia consumed.

All employes (engineers, oilers and repairmen) who assist in keeping the system tight and saving the ammonia should share in the bonus.

Each plant shall report on the first of each month on forms to be furnished later by the United States Food Administration as follows:

(a) Amount of ammonia in the system when it is fully charged.

(b) Amount of ammonia put in during the past month.

(c) Amount that will probably be required for the present month.

(d) Ice made during the past month.

(e) Average daily refrigerating duty (in tons refrigeration) during past month (aside from ice making).

(f) Manufacturer furnishing the ammonia.

(g) If you have had excessive ammonia loss, state cause.

(h) State the amount of uncharged ammonia on hand, ... lb. Anhydrous ..... lb. Aqua.

(i) Have you adopted a "bonus system" as recommended by the government?

Ammonia conservation means stops the leaks. Plants made tight, kept tight, and carefully handled will not waste ammonia. Remember the boys in the trenches need it!

How far and how long ammonia can be spared for refrigeration cannot now be said. Plants most extravagant in its use will naturally be closed first. The efficient plants which use little or no ammonia are in the best position as far as this question is concerned.

The patriotic duty performed in saving ammonia at this time will make your enthusiastic co-operation a pleasure and a privilege. Let the slogan all over your plant be stop the leaks—save ammonia and help win the war!!!

Fusible, or Safety Plugs

A Discussion of Types, Construction and Application. By Receiver.

TWO common forms of these plugs which are shown in the illustration consist of a brass shell having cut on the outside a standard pipe thread, and a tapered hole through the inside. This hole, which formerly was filled with a soft alloy of tin, lead and bismuth, is now filled with pure tin, a substance more generally preferred.

Fusible plugs are used in boilers for the object of warning the attendant of the fact that the water in the boiler is low and unless immediate attention be given the matter, part of the heating surface will be exposed to the direct action of the fire.

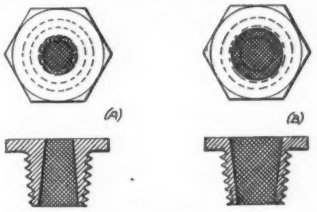
These plugs are usually so located that they will be subjected to the temperature of the hot gases in the first pass of the boiler and also, in reference to the water line, so that when the water shows in its glass the plug will be well covered, or, in other words, the plug is placed about 1 in. below the bottom of the glass.

In the return-tubular boiler, the highest heating surface is the top of the upper row of tubes and in this type of boiler, the plug is located in the center of the back head, about 2 in. above the top row of tubes. Due to being screwed into the head from the outside, it is known as the "outside" type, as shown at A.

In a water-tube boiler, such as the B. & W., the plug may be located at one side of the front drum sheet, about 6 or 8 in. from the bottom of the drum, and either the inside or the outside type of plug may be employed, such as are shown at A or B of the illustration.

The inside style of plug as its name implies, is put in from the inside of the boiler and differs from the other in the fact that the taper hole is made with its large diameter at the head of the plug; while the outside type has its large diameter of the taper end of the plug opposite the head. The object of this manner of construction is self-evident when it is remembered that the use of the taper hole allows the pressure to act on a surface of metal whose area is greater than that exposed to the heat of the furnace, and thereby assist in holding the fusible metal in place.

As water is a good absorber of heat, it absorbs the heat from the fusible metal almost as fast as the plug receives it from the gases, so that heat cannot accumulate and melt the plug. On the other hand, it is known that steam does not possess the property of heat absorption to as great an extent as water and when the plug is exposed to steam, it will retain the heat and consequently the metal will melt.



A—OUTSIDE TYPE OF FUSIBLE PLUG
B—INSIDE TYPE OF FUSIBLE PLUG

Fusible plugs are made with either square or hexagonal heads and with a minimum diameter of soft metal of 0.5 in. for pressures up to and including 175 lb., while, for the higher pressures, the least allowable diameter is 0.375 in.

Firemen in charge of boilers should use every precaution to see that the inner end of the plug is free from scale and the outer end from soot or deposits from leaks. When the metal extends the entire length of the plug, the extreme end which does not enter the head or shell plates transmits the heat so slowly, that the filling melts up to that line at which the plug enters the plate, resulting in a higher temperature than that rated, being required to melt the rest of the metal. To overcome this, many plugs are now made in which the metal fails to come to the exposed end of the plug by an amount equal, in the inside type, to the thickness of the head, and in the outside type by 0.5 or 0.625 in. When the metal has melted but part way as above described, many engineers have been known to renew a plug although it was in good condition.

Whenever a plug melts, the fires should be covered as quickly as possible and fire doors and dampers opened, allowing the boiler to cool. If the water level cannot be determined, it is best to draw the fires and carefully examine all parts of the boiler, and if all is in good condition the plug may be renewed and the boiler filled to the proper water line.

Reducing Belt Slippage

By W. F. Schaphorst

I HAVE read much material relative to belts and pulleys and have a number of times seen it claimed that slipping was stopped by drilling holes through the rim of the pulley, thus allowing the "entrapped air" to escape. It was also claimed in connection with these articles, that belt compounds and higher tensions failed to stop the slip.

I have a number of times tried to find air currents around pulleys due to the running on and off of the belt, but have never succeeded. Hold a lighted match close to a high-speed pulley and the direction of the flame will show the direction of the current of air. It will be found that the current is practically nil. For that reason I have not taken much stock in the air cushion theory. It may be that such a thing exists; but if so, why isn't there a vacuum on the side of the pulley from which the belt leaves? This vacuum would have a tendency to hold the belt against the pulley and thereby aid the pulling powers of the belt. Thus the vacuum would neutralize the effect of the air cushion.

It is true that a flat pulley may have a tendency to form a sort of air cushion more readily than would a crowned pulley; but air being so light, I cannot understand how or why it should persist in being dragged through with the belt. Air cannot be pulled along as if it were a piece of cloth. And as for a crowned pulley, the air is there "pinched out" in two directions, whereas with a flat pulley it is pinched out in one direction only.

Not long ago, a certain pulley manufacturer drilled holes in all of the pulleys he made, with this air cushion idea in mind; but I have not seen them advertised for several years, so it looks as if the idea sort of "fell through." Of course, I may be mistaken.

It occurs to me that if these experimenters who have drilled holes in their pulley rims, would try inserting corks in them, perhaps the pulleys would work even better. Cork insert pulleys are on the market now and are giving satisfaction. It is a fact that the coefficient of friction between cork and leather is high, but as for the advantages attached to drilling holes, I "hae me doots."

Holes drilled in a pulley rim may represent one-hundredth of the area of the pulley—perhaps even less. How can all of the air find its way through this small area? Why should it find its way through this small area when it is so much easier to escape along the periphery? Besides, it must be remembered that in forcing air toward the center of a shaft it is being forced against centrifugal force. The natural tendency is for the air to flow outward and not inward.

Here is a method that will be found handy for determining belt slip if conditions in a given drive are such that the driven pulley can be operated for a while "without load."

The method is based on the assumption that when no power is being transmitted through the belt there is no belt slip. That surely is logical. The driven pulley, then, will rotate as many times per minute as it is possible for it to rotate. When the belt is transmitting full load, however, there is bound to be belt creep and possibly some slip, and the driven pulley will not rotate as rapidly as when "unloaded." The difference in the number of revolutions per minute then, divided by the number of revolutions per minute made "unloaded" multiplied by 100, gives the percentage of slip.

For example, let us say that the driver pulley runs 200 r.p.m., while the driven pulley runs 340 r.p.m. in an unloaded state. When the belt carries full load, though, the driven pulley makes only 320 r.p.m. What is the percentage of slip?

Using the above rule we get:

$$\frac{340 - 320}{340} = \frac{20}{340} = 0.059$$

$0.059 \times 100 = 5.9$ per cent slip.

Belt slip is an important item because each per cent of slip virtually means a loss of one per cent of the yearly coal pile. If this slip can be reduced to 2 per cent (and it should), the yearly saving on coal expenditure would be about 4 per cent.

In order that there can be no misunderstanding about the rule, here it is in the form of a formula:

$$\text{Per cent slip} = 100 \left(\frac{\left(\begin{matrix}\text{R.p.m. driven pulley} \\ \text{when "unloaded"}\end{matrix}\right) - \left(\begin{matrix}\text{R.p.m. of driven pul-} \\ \text{ley when "loaded"}\end{matrix}\right)}{\left(\begin{matrix}\text{R.p.m. of driven pulleys} \\ \text{when "unloaded"}\end{matrix}\right)} \right)$$

A Power Plant Regiment

The Signal Corps authorizes the statement that 10,000 machinists, mechanics, chauffeurs, and other skilled workers are needed at once by the Aviation Section, Signal Corps.

The present call for 10,000 men is to fill an immediate need and will be followed by others as the service is being built up.

The dependence of the Air Service on the most highly skilled men is being brought out more emphatically with every week of development, and practically 98 men out of every 100 in the service must be skilled in some branch of work.

Secretary Baker recently expressed this situation as follows: "The great problem now remaining is to secure the thousands of skilled mechanics, engine men, motor repair men, wood and metal workers needed to keep the planes always in perfect condition. This great engineering and mechanical force at the airdromes, flying fields and repair depots, both here and behind the lines in France, is a vital industrial link in the chain of air supremacy. Without them the planes turned out would be useless and the flyers helpless."

Men registered in the draft may be inducted into this service by applying to their Local Draft Board. Men not registered may enlist at any recruiting office. Further information may be had by applying to the Air Division, Personal Department, Washington, D. C. In either case they will be sent to San Antonio, Texas, for segregation by trades, followed by a brief course of instruction at the flying fields or at various factories and organized into squadrons mostly for service overseas.

The present call includes machinists, auto mechanics, engine repairmen, chauffeurs, blacksmiths, electricians, wireless operators and constructors, welders, and makers, repairers and installers of magnetos and ignition systems.

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The Cost in Coal of Avoidable Belt Slip

AVOIDABLE losses are the ones to stop, always, especially if they can be stopped at small expense.

Never before have we understood the strategic and money value of coal as thoroughly as we do now. Never before has it been so necessary for us to save, even though considerable money must be spent in order to effect the saving.

One of the very simplest losses to overcome, however, and at small expense, is belt slip and since belts are used to so great an extent it will pay to look into the matter with more thoroughness than has been given it in the past. To show the extent of the loss of money through slipping of the main belt alone a chart, supplied us through the courtesy of the Cling-Surface Co., Buffalo, N .Y., is shown in the Practical Reference Tables, upon which this is easily ascertained. By glancing up and down column "D" of this chart it is evident that the "Cost of Avoidable Belt Slip per Year in Dollars" may vary all the way from the smallest sums into the thousands of dollars.

Where the power in the first place is generated by a steam engine and is then transmitted to a generator or to the main shaft through a main belt, it is evident that the "entire coal pile" passes through that in the form of energy, literally speaking. If the belt slips, which it should not do, a certain portion of the coal pile does not "get through," but is lost into the atmosphere in the form of waste heat. A main belt is merely a "link" connecting the engine with the generator or with the machines themselves. In fact, every belt that transmits power is a connecting link and the efficiency of that link depends largely upon the freedom from slippage and the avoidance of strain on the shafts. Slipless, easy running belts are most desirable.

A Power Plant Is a Train of Links

For the moment, it might be well to dwell upon this thought, as it is seldom looked at in just this light.

We have for the first link the coal on the grates which only perfect combustion can turn into maximum heat; next the boiler shell and tubes—they must be clean to bring the heat link to the steam link; next the steam line from boiler to engine or turbine—large enough and well insulated; then the engine or turbine link which joins heat energy and mechanical energy—only careful design, proper valve setting and much care minimize losses here.

Then, where power is distributed solely through belts and pulleys, the belts, pulleys, and shafts or electrical cables to the final motors and belts are the connecting links up to the very machines themselves.

If the efficiency of every link is maintained at its highest point, the power end of the plant is beyond criticism; the overall efficiency will then be very high. But if the efficiency of every link is low or indifferent, the overall efficiency of the power end will be distressingly low.

Mere Matter of Detail?

Many of us talk glibly about efficiency as if it could be acquired over night. Thus one man has stated that "Efficiency is a mere matter of detail." His definition is all right, but detail is not a "mere matter."

Belt Slip Is Not a "Mere Matter," Either

For these various reasons, therefore, it is plain that power transmission through belting is a "detail" on which we should "plug" until all avoidable slip is eliminated. It is especially important, as stated before, where all the power passes through a single main drive belt. Each per cent of slip in such a belt represents a loss of one per cent of the coal pile.

Roughly, 2 per cent of the potential power in the driving pulley of the engine is represented by "belt creep." Its loss is unavoidable because of the elasticity of the belt. This has been recognized and provided for in the chart, so the reader can go ahead and connect known values, while the intersection with column "D" gives the avoidable money loss.

Simply zigzag across the chart twice with a straightedge, as shown by the dotted lines, and the money loss is immediately found. Thus, if the total belt slip is 6 per cent (column "A") and the cost of coal per ton is $4 (column "B"), run a straight line through those two points and locate the intersection with column "C." Then from that point of intersection run over to the tons of coal burned per year (which in this instance has been stated as 1000 tons) and the cost of avoidable belt slip per year is shown by column "D" as being $160.

For $160 one can well afford to give a little time every month to the care of the belting. Yearly loss due to belt slip is often considerably greater than $160, for it must be remembered that this chart applies only to one belt—the main belt. If all of the distributing or secondary belts slip equally as much the yearly loss is double, triple, or even four times as much as $160.

To give a clear idea as to the meaning of "Total Belt Slip Per Cent" let us take an example. You find by means of a revolution counter that a given driven pulley is rotating only 940 times a minute. You figure that without slip it should rotate 1000 times a minute; 60 r.p.m., therefore, are absolutely lost. Dividing this 60 by the revolutions per minute that pulley should make you get 0.060, or 6 per cent, which is the "Total Belt Slip." After having made this determination, now it is a simple matter to apply it to the chart, as has been done, and determine the money loss per year due to such slip.

Furthermore, belts which do not slip do not require tension and can be run easy or slack; every belt thus relieved of its tension reduces by that much the total plant friction load and this means also a longer-lived belt, cool bearings, less oil used, less time of men and machines lost during repairs and more power at the machines, for friction represents lost power.

Coal Orders

In the comfort of the warm days of Spring, we must not forget the heatless days recently past. By ordering and taking delivery now of coal for next Winter's needs householders and manufacturers will not only be safeguarding against inconvenience next year, but will help greatly to avoid next January the condition of shortage that was so disastrous this year. Place orders now. Help to keep the mines and cars busy all the year.

Industrial Plant Furnishes Street Railway Power

OBTAINING a high load factor is one of the problems to which the operating engineer of an industrial power plant gives practically no attention. Usually he can do nothing with the problem because the amount of the load and the time at which it is required is entirely out of his control. Since his plant serves but one industry there is no opportunity for him to secure the diversity of use which is the salvation of the central station; however, it is often possible by looking around to find outside uses which will extend the period of peak load without increasing its magnitude, and at the same time materially benefit the new power user. An interesting example of this is the supply of direct current by the Westinghouse Electric and Manufacturing Co. to the Pittsburgh Railways Co. for the operation of their cars in and about East Pittsburgh, Pa. Due to the tremendous increase in employes at the Westinghouse plant, the present overhead equipment of the street railway was overtaxed for about two hours, morning and evening. Since the railway company's generating plant was also heavily loaded at these times, it was considered better to buy current from an existing plant rather than erect a railway substation or string additional copper in feeders. Accordingly, connections were made between the railway feeder system and the Westinghouse Co.'s rotary converter capacity in its power house, and arrangements were provided to supply direct current at

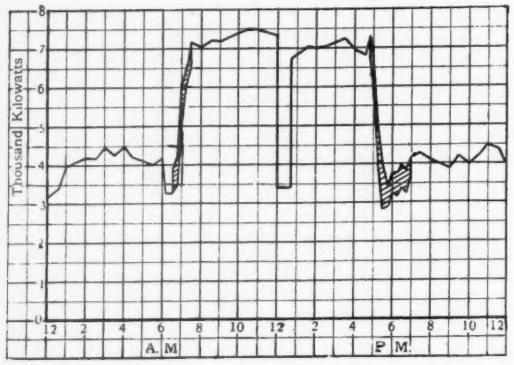


FIG. 1. DAILY LOAD CURVE; SHADED PORTION INDICATES POWER DRAWN BY RAILWAY COMPANY

500, 550, 600 or 650 v., according to the railway need. As will be seen from the daily load curve, the amount of the day's demand was not increased, but its duration was somewhat lengthened, the shaded area indicating the power furnished by the manufacturing company.

As will be seen from the map, Fig. 2, street railway transportation to East Pittsburgh is furnished over but three lines northwest and one line east. On this account, the traffic congestion is very great at morning and evening. With the old conditions there were often annoying or even serious delays due to power shortage. Since this new arrangement has been in operation, however, there has always been plenty of power to move cars at any time.

There are, no doubt, many industrial companies similarly located with respect to transit lines extending out a considerable distance beyond the last substation, which could use such a method with great advantage. While the revenue from the sale of power is, of course, desirable, the principal benefit will be found to be in the getting of employes to and from work on time, in which an ample supply of power is a very important factor.

Coal Prices in Washington, Oklahoma and Arkansas

BEGINNING March 29, the prices set for Washington are: Screened bituminous for Kittitas Co., run of mine, $3.55; prepared sizes, $3.95; steam and gas, $3.25; slack, $2.50. For sub-bituminous of Lewis and Thurston Co.'s, run of mine, $2.75; prepared sizes, lump, $3.95; lump nut, $3.25; nut, $3; slack, $1.25. For washed coals: Kittitas Co., $4; Pierce, King, Lewis and Skagit Co.'s, prepared sizes, $6; steam, $5.25; King Co. prepared sizes, lump nut, $5; pea, $3.50; buckwheat, $3.25; slack, $1.50; Lewis Co. lump, $3.95; nut, $3.75;

FIG. 2. VICINITY OF EAST PITTSBURGH, PA., SHOWING TROLLEY LINES SERVING THE DISTRICT

pea, $3; buckwheat, $1.50; slack, $1.25. Preparation must conform to rules approved by the State Mine Price Board.

For Arkansas bituminous, the prices are: Johnson, Franklin and Sebastian Co.'s, except the Excelsior District, run of mine, $3.70; prepared sizes, $4.60; slack, $2.40. For Logan and Scott Co.'s and the Excelsior District mines on the Midland Valley R. R. (a) north of Montreal Junction and (b) east of Hackett and west of but not at Greenwood, run of mine, $4.35; prepared sizes, $5.15; slack, $2.60. For operators who have complied with the Washington wage agreement an allowance of 45 c. a ton additional is made to these prices.

For the summer, reductions in prices are made on all grades except slack of 75 c. a ton for March; 60 c. for

April,; 45 c. for May; 30 c. for June; 15 c. for July. On August 1, the base price again becomes effective.

In Oklahoma, prices will be for Leflore, Haskell, Okmulgee, Tulsa, Rogers and Coal Co.'s, and the Hartshorn-Willburton vein in Pittsburg and Latimer Co., run of mine, $3.70; prepared sizes, $4.60; slack, $2.40. For the McAlester vein in Pittsburg and Latimer Co.'s, run of mine, $4.25; prepared sizes, $5.10; slack, $3.

Summer reductions are the same as for Arkansas, and operators complying with the Washington wage agreement are allowed to add 45 c. a ton to the foregoing prices.

Bonus for Special Cleaning

For all bituminous mines in the country, where special means for eliminating impurities are used, operators will be allowed to add 20 c. a ton to the base prices at the mine, this allowance extending from April 1 to July 31, 1918. Operators taking advantage of this order will be granted special permits, but retail dealers may not add this allowance to their prices unless they too obtain permits. Such specially cleaned coal will be designated by cards placed on the cars in which the coal is loaded and by notations on the invoices for the coal.

Follow the Flag

By John Pierce

IF YOU would not be a slave,
Follow the flag—
If you'd help Old Glory wave,
Follow the flag—
Follow the flag to Sunny France—
Help the glorious cause advance—
And for freedom take a chance—
Then follow the flag.

If you can't go o'er the sea,
Follow the flag—
We can help; both you and me
To follow the flag—
We can work both day and night—
Do our "bit" and do it right—
Helping those who go to fight
And follow the flag.

Let us not go out on strike—
But follow the flag.
Though our wages we don't like—
Let's follow the flag—
Skimp a little here and there—
In foolish spending have a care—
Sacrifice for those who dare
To follow the flag.

Let us buy a bond or two,
And follow the flag—
Just to show our colors true—
Oh follow the flag:
And like those who go, and die,
Let's be brave, both you and I,
And to prove our worth let's try.
Come, follow the flag.

Meatless days may oft appear,
But follow the flag—
Sugar's high—and bread is dear—
Just follow the flag—
Remember those across the sea,
Fighting that the world be free,
Get as hungry as do we—
Yet follow their flag.

Let us, while the war is on,
Follow the flag—
Do our best until it's won,
Follow the flag—
Then when peace has come again
Loud will ring this glad refrain—
"We through sacrifice and pain
Followed the flag."

Although your purse be empty—quite,
Follow the flag.
Though you miss the show tonight,
Follow the flag—
No tobacco to smoke or chew,
All looks black and life seems blue—
War sure is hell—no work to do,
Still follow the flag.

But—a time will come all right—
If we follow the flag—
When the sun of life shines bright,
So follow the flag—
We'll forget griefs of today—
Strife and hardships of the fray;
To the world we'll proudly say,
"We followed the flag."

Parcels for Soldiers Abroad Restricted

By request of the War Department, the post office has issued an order that in future parcels for individuals in the American Expeditionary Forces in Europe shall contain only articles requested by the one to whom they are sent, and the request approved by his regimental or higher commander. The approved written request must be enclosed in the parcel, and on the outside must be endorsed: "This Parcel Contains Only Articles Sent at Approved Request of Addressee, Which is enclosed." All other parcels will be returned to the sender.

Go the limit in supporting the boys "over there." Liberty Bonds afford the means for your doing so.

"Thy kingdom come" is a petition that may be answered through the Third Liberty Loan. Make your purse and prayers hang together.

Pray and pay for the Third Liberty Loan.

Support of the Third Liberty Loan makes a practical patriot of you.

Investments in Liberty Bonds will show the lad in the trenches that he is not forgotten, and will hearten him to strive for an early victory.

It is not a donation to the government, this buying of Liberty Bonds, but the sanest, safest investment in the world.

Some Repairs and Experiences

THE BALL OR SEDIMENT chamber of a water column froze and burst. We repaired it by sawing off the ball, leaving as much metal as possible on the column end to give room for drilling and tapping. We drilled and tapped for 1-in. pipe connection and used a 1 to ¾-in. bushing. The job is doing fine, with no leaks, and appears to be good for the life of the column.

One of our boiler feed pumps was badly worn and the pistons were in such shape that packing them was almost impossible. I fitted a section of 3-in. double strength pipe over the worn piston bodies, which fit them very tightly, and changed the size of packing used, and that pump is good for many a day. Care should be taken in cutting pipe so exact distance between parts of plunger is maintained.

Four of my condensing chambers on hydrostatic lubricators froze and burst, due to neglect in not draining them. Having no time to braze them, I simply used

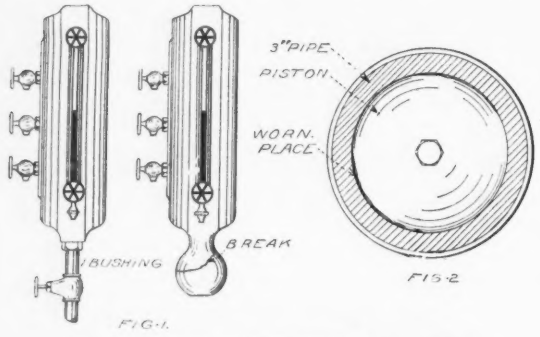


FIG. 1. BROKEN WATER COLUMN REPAIRED
FIG. 2. SECTION OF REPAIRED PUMP

a piece of ½-in. pipe 12 to 18 in. long and all are working satisfactorily.

On taking charge of a plant in this city, I was promised a substantial increase in the salary paid the former engineer if I could cut the running expenses. This was easily done, as I first took 700 lb. of scale out of one of the boilers, had stack raised by help of smoke inspector so I had 0.33 in. draft instead of 0.17. I arranged the damper to set at various positions, depending on load, used exhaust steam to heat water for the buildings and raised the temperature from 140 to 160, which was the limit before, to 180 to 210, live steam and a gas heater was used before. Next, I put in a shaking grate, and that boiler used 19 tons coal less the first month the grate was under it. I now had figures showing a steady decrease in amount of coal burned and according to the manager the service was better than before. I asked for the aforesaid raise and was informed that they considered it an engineer's duty to do as I had, could not afford a raise. I raised myself out and am making $30 a month more than I received there; however, they had to grant an increase in salary later, so I'm glad someone benefits thereby.

When I went there, a 6 by 4 by 6-in. duplex boiler feed pump was doing its best to feed one 72-in. by 16-ft. return tubular boiler and having a hard time. As rods and barrels were badly worn, I asked a price on having the pump overhauled; $75 was the least I received, so I bought new rods and liners and put them in myself, saving $35, and got practically a new pump. Some engineers may feel a bit backward about taking out and replacing liners; however, it is not hard. A pulling rig can easily be made or it is possible to remove the rod and gland and start the liner with a bar. I have moved them simply by tightening the packing, removing the head and letting the pump move slowly.

The set screw in the collar on the valve stem of a duplex pump was broken off and could not be tightened, and was constantly slipping, allowing the pump to stick. Having no time to dismantle the pump valve gear and repair it properly, I wound two springs between collar and gland and have no trouble with the collar slipping; however, when the 20 ft. of ice on top of the pump goes out (our plant is flooded), I'll try to fix it right provided any pump is left.

C. H. Willey's lead wire gasket appears to cross itself at every bolt; if it does, I should look for it to leak. A cheap and durable gasket can be made from pasteboard. I am using several on water and steam. Graphite them well and they can be used over again. J. C. LEE.

Air-Bound Fire Pumps

A SHORT TIME AGO, I had charge of a steam plant which had previously installed a Blake-Knowles fire pump, 18 by 12 by 18 in., capacity, 1600 gal. per min., which had 16-in. suction and 10-in. discharge.

This pipe ran out through the factory yard where the hydrant and sprinkler pipes were taken off; it was also connected to the city main, which had a pressure of 80 lb., and had a check so we could not pump back into it, to be used only in case the pump failed. The discharge from the pump had a 10-in. gate valve, also a check.

The suction had a 12-ft. lift with a foot valve at reservoir; the reservoir was supplied from the overflow from two condensers. The auxiliary fire pump was a Warren duplex, 4 by 2½ by 5 in., which was supposed to hold the pressure of 100 lb. on hydrant and sprinkler system, both pumps were controlled by a Fisher governor, so in case of a fire the pump would start automatically.

The suction of the auxiliary pump was piped to the suction of the main pump, and the discharge was piped outside of the check on the main pump; but this would not work, and gave a lot of trouble. The ½-in. pipe to the pump governors was also taken off outside of the check, the governor on the main pump was set for 90 lb. and on the auxiliary pump for 100 lb. This pump would get air-bound and would not keep the suction pipe full. On the main pump, the pressure would fall too low, the main pump would start, and this would become air-bound and short stroke and would not lift the water; so I thought it over and decided to make the following change:

I took the suction of the auxiliary pump and ran it about 30 ft. into a tank which was used for feed water for boilers. This was supplied by a 3-in. pipe from a brook a quarter of a mile from the mill.

I had a check put on the end of suction, and the discharge I piped into the suction of main pump. The pipe to governor was tapped into this and the pipe to governor on main pump was connected to distribution chamber of the main pump. The auxiliary pump was started and the suction pipe filled this, flowing through valves on the main pump and out on the main pipe line. This kept the suction pipe and pump full all the time.

These pumps were tried out by the fire inspector several times and were pronounced the best working pumps he had ever seen. We had no further trouble with the pump being air-bound. FRANK N. ALLEN.

Cast-Iron Flywheel Speeds

THE SOLUTIONS (or equations) to problem, "What is the highest speed at which a cast-iron flywheel may be safely run?" on page 978 of the issue of Dec. 15, 1917, is erroneously expressed. The equation as given is:

$$\text{Max. Velocity of Rim in ft. per second} = \sqrt{\left(\frac{\text{Tensile Strength}}{\text{Factor of Safety}}\right)} \div \text{(Weight per sq. in.)}$$

Let w = weight of rim in pounds; R = mean radius of rim in feet; r = revolutions per minute; g = 32.16; v = velocity of rim in feet per second = $2 \times 3.1416 \times R\,r \div 60$. Then centrifugal force of whole rim = F

$$= \frac{w\,v^2}{g\,R} = \frac{4 \times 3.1416^2 \times w\,R\,r^2}{3600\,g} = 0.000{,}341\,w\,R\,r^2.$$

The resultant, acting at right angles to a diameter of half of this force, tends to disrupt one-half of the wheel from the other half, and is resisted by the section of the rim at each end of the diameter. The resultant of half the radial forces taken at right angles to the diameter is $1 \div \frac{1}{2} \times 3.1416 = \frac{2}{3.1416}$ of the sum of these forces; hence the total force, F, is to be divided by $2 \times 2 \times 1.5708 = 6.2832$ to obtain the tensile strength or strain per cross section of the rim, or, total strain on the cross section = S = $0.000{,}054{,}27\,w\,Rr^2$.

The weight, w, of rim of cast-iron 1 in. square in section is $2 \times 3.1416 \times R \times 3.125 = 19.635\,R$ lb. Whence strain per square inch of sectional area of rim = $S_1\ 0.001{,}065{,}6\,R^2r^2 = 0.000{,}266{,}4D^2r^2 = 0.000{,}027{,}0V^2$, in which D = diameter of wheel in feet, and V is velocity of rim in feet per minute.

$S_1 = 0.0972\,v^2$ if v is taken in feet per second.

Now, then, assuming the tensile strength of cast iron to be 10,000 lb. per sq. in., and assuming 10 as a factor of safety, then the maximum strain per square inch in cast-iron wheel rim $= \frac{10{,}000}{10} = 1000$ lb. per sq. in. Hence, the maximum velocity of rim in feet per second is:

$$V = \sqrt{\left(\frac{\text{Tensile Strength}}{\text{Factor of Safety} \times 0.0972}\right)}$$

$$V = \sqrt{\left(\frac{10{,}000}{10 \times 0.0972}\right)}$$

$= 101.+$ ft. per sec. = Answer.

The solution of W. P.'s equation is equally faulty; it is solved thus:

$$V = \sqrt{\left(\frac{10{,}000}{10}\right)} \div 0.26 = 62 \text{ ft. per sec.}$$

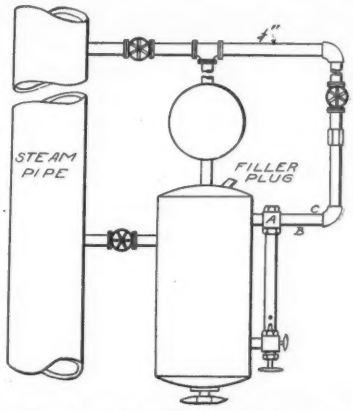
But,

$$V = \sqrt{\left(\frac{10{,}000}{10}\right)} \div 0.26 = 121.24$$

JOHN BACK.

Aiding the Lubricator

HAVING HAD considerable trouble with the pipe operation of a hydrostatic lubricator installed in a cold place and used to lubricate the cylinder of a blowing engine, I changed the piping as shown in the accompanying



SCHEME OF CONNECTIONS EMPLOYED WHICH MATERIALLY AIDED OPERATION OF LUBRICATOR

illustration. As a result, I find that my former troubles have been entirely eliminated and in addition I can use any cheap cylinder oil with satisfaction.

Soot Problem

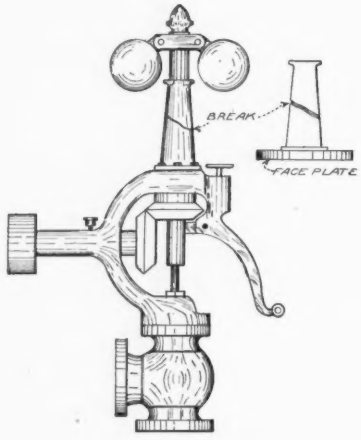
IN THE MARCH 1 number of Power Plant Engineering E. R. wants to know what will prevent the deposit and caking of soot in the tubes of his boiler. I wish to say that the plant of which I have had charge for the past 12 yr. has five 66-in. by 16-ft. return tubular boilers equipped with Hawley down draft furnaces which have given excellent results with never a trace of hard soot caked in the tubes; in fact, this is one of the advantages of a down draft furnace, that it will not deposit soot to amount to anything, at least not as much as an updraft furnace will, due to the fact that it is a perfect smoke consumer if properly handled.

In E. R.'s case, the formation of soot is evidently due to incomplete combustion, to too much green coal thrown on at one time and to low furnace temperature with insufficient air. In order to operate a down draft furnace most economically, there should always be from 10 to 12 in. of fire carried on the upper grate or tubes, which requires quite a sharp draft. Maybe this is lacking in E. R.'s plant; or it might be that he has too much grate surface in use for the amount of steam required. The coal consumed per square foot of grate should never be less than 12 or 14 lb. per hour, figuring both upper and lower grates and firing upper only. If E. R. is running under partially closed dampers, I would suggest either to cut down the upper furnace by filling in with some light material on the rear end, or to bar up only such length as would keep fires bright and sufficient steam, letting the coke formed in the rear act as a dead plate.

F. C. Ruck.

Using the Oxy-Acetylene Flame to Advantage

When the upright of the governor of the engine of which I had charge, broke as indicated in the accompanying illustration, the boss, thinking he would have to invest in a new one, flew into a rage. I, however, quieted him somewhat telling him I could repair the governor with but little trouble and expense by employing the oxy-acetylene flame. Accordingly, I set about and dismantled the governor, after which, as indicated in sketch, I filed a V-shaped groove along the fracture, placed the two members upon a face plate and when properly lined up, I applied the flame and



THE BROKEN GOVERNOR AND METHOD EMPLOYED TO REPAIR IT

joined the two pieces. After the weld was completed, I filed off the rough surfaces, applied a coat of paint and re-assembled the governor and placed it in operation.

When the boss saw what I had done, he was more than pleased and said the job had been so well done as to make the governor appear like new.

W. Davenport.

Oxy-Acetylene Welding for Engineers

Regarding the formation of hard scale accompanying the welding of cast iron as mentioned by Chas. Haeusser on page 209 of the March 1 issue, I would like to state that I cannot account for this unless it may be caused by an excess of oxygen or by impurities in the iron. Care should be taken to have the members to be welded perfectly clean and above all use a good flux; also select your cast-iron rods with care, using only soft iron high in silicon.

A good flux for cast iron is one made of equal parts of carbonate and bicarbonate of soda, to which add 10 to 15 per cent of borax and 5 per cent of precipitated silica. Sodium chloride (common table salt) may also be used.

The flux should be used sparingly, just enough to make the metal run freely; too much causes the iron to harden so that it cannot be drilled or machined.

H. E. Notthoff.

How Do They Figure It?

The phenomenon described under the above title in the March 15, issue, might be accounted for by one of the following explanations:

The electricity may have been metered and the water may have been on a flat rate, in which case it would, of course, be cheaper for the householder to use water.

If both were metered it may be due to the methods of figuring rates for the water and electricity. Rate making seems to be a very complicated but inexact science. For instance, some towns have uniform water rates for all consumers and sliding scales on electricity of from $0.15 to $0.015. If a householder pays for electricity at the rate of $0.15 per kw.-hr., and pays for water at a uniform rate based on a pumping cost for electricity of $0.015, it is plain that, other things being equal, the water would cost the householder less. In the case mentioned by Mr. Near, it may be that the pumping to the reservoir is done during off peak periods on the lighting plant, which arrangement would entitle the water department to a still lower rate for electricity.

Regarding the respective efficiency, that of the electric motor is probably higher than that of the water motor; but the actual efficiency of all very small powers and transmissions is so notoriously low and so many other factors have a greater bearing on the results obtained, that actual "efficiency" is hardly worth considering.

Burt N. Everett.

Thawing Frozen Pipes by Electricity

I took charge of the light and water plant, a municipal affair, Dec. 1, 1916. Some of the water lines were not very deep under the ground and the result was frozen up services and then complaints. As we don't want to pay for what we do not get, I took it up with the board as to what we had better do and they instructed me to get men and have pipes dug up. So I got two men on the job and after they had put in one day and till 10 a. m. next day, I came to the conclusion that it would cost more to dig it up than it would be worth if we would give the consumers free water for several years. I talked it over with the electrician and he was very sure that it would not work, but for all the

opposition I said we would try it anyway and then we would know for ourselves.

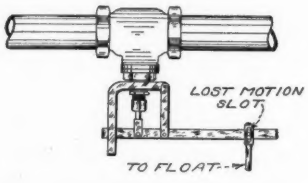
We have 2200-v. alternating current, and looking around, I found a 25-k.v.a. transformer not in use, so I got a wagon and loaded up the transformer and an empty barrel and ammeter, filled the barrel about ⅔ full of water and was ready for work. I connected up the transformer through the ammeter, using the barrel of water as the rheostat on the primary side, putting a hook on the line long enough to reach the primary lines on the poles, using some old cables and 00 wire that I found lying around; connected the 110-v. side of transformer, one lead to fire hydrant and the other one to the faucet in the sink where the service was frozen up. Dropping the other high tension line into the water completed the circuit, lowering the terminal increased the amperage. It would depend on how hard the service was frozen as to how long it took to thaw out the pipe. In one case it took only one to two min. to start the water to run. We thawed out 10 services in all.

This winter we had more calls for the outfit as it was a much colder winter. We thawed out 48 services, three fire plugs and one square of 4-in. main, taking 30 to 40 min. to thaw out the fire hydrant and about 60 to 70 for the main. This is a rather crude affair, but it did the work. There was a firm wanted to charge us $195 for an outfit that would have looked a little better, possibly, but it was not looks we were after, and all the extra expense we incurred was the work, as in either case the power would be the same.

A. G. C. McKalip.

Stopping Chattering of Regulating Valve

We had in service a combined returns and make-up tank which received returns from some drying machines and which also was fitted with a float and regulating valve for admitting city water when the returns were insufficient for the feed supply. The returns came back in slugs at times and as a result the float often was raised suddenly and the city water supply cut off quickly. When this happened, the float would not find its proper level for a short period, during which it



METHOD EMPLOYED TO STOP CHATTERING OF REGULATING VALVE

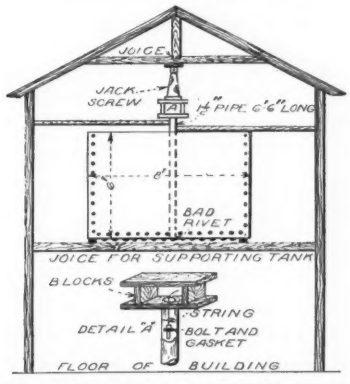
moved up and down a matter of an inch or two, while motion was communicated to the regulative valve and caused chattering. The city water pressure was about 50 lb. This chattering when the valve was seating was very annoying because of the accompanying noise.

After trying a heavier counterweight without success, it occurred to us to prevent the final fluctuations of the float from being transmitted to the valve, and to do this we altered the connection between the float and connecting rod and regulating valve lever as illustrated. The connection was originally made with a small pin set in holes bored in the two members. We changed this by making a long slot in the connecting rod part so that it was necessary for the float to move ½ in. in either direction before its action would be felt by the regulating valve. This lost motion served to take up all the final convulsions of the float as it was finding its upper level and it eliminated the trouble from chattering which was previously experienced. M. A. Saller.

Replacing Defective Tank Rivet

I will try to explain how I repaired a tank job. We use a steel tank for our water supply. This is made up of plates riveted together, and with one of the seams at the bottom of the tank. One day when our only supply pump was down for repairs, a rivet in this lower seam sprung a bad leak; we could not afford to lose the water as we depended on it to refill our boiler which was down for cleaning.

I took a 1½-in. pipe and fastened a rubber washer to one end, thrust it down so as to cover the bad rivet, then braced the top of it and applied a jack screw to



METHOD EMPLOYED TO REPLACE DEFECTIVE TANK RIVET

the top of the pipe on built-up bridge work so as to be able to let down a bolt through the pipe to the rivet hole. Above the tank was a joist, so I backed the jack against this joist and stopped the leak. After the water had all run out of the pipe, I bored the rivet through so as to make it thin as I could, cut it off easy, so as not to disturb the other rivets, and then punched through the remaining parts; then let down bolt with a gasket on next to head with a string and after the bolt came through I put on burr and tightened it up. I then removed the jack and pipe. G. H. Smith.

Cylinder Wear

Two years ago, the writer had the same experience as J. D. C., described on page 223, March 1, issue, while overhauling one 350-hp. Corliss, and two high-speed Ames engines, 75 and 125-hp.

We found that the cylinders had worn large on the ends. The smallest of our engines had worn more than the others.

We turned them all down a little, the smallest one 1/16 in. The only reason I can see for this condition is that the steam acts directly on the side of the piston

when the piston is on the center and valve open for lead. Lay a straightedge on the bottom of the cylinder or right opposite where steam is admitted and you will find that the cylinder has worn more there than anywhere else. CHARLES MAGNUS.

Marine Engineers' Examination Questions

MANY STATIONARY PLANTS are operated by former marine engineers who, with those stationary engineers who may desire to enter service in our new merchant fleet, should find the following questions asked in a recent examination for a first assistant's license of ocean-going steamers of unlimited tonnage of value.

In passing, it may be said that the questions relative to the safety valve, salinometer and stay bolts go to Washington, while the others are retained in the local office. The examination is written and one may take as much time as necessary to finish it. He may be examined any day and no fee is required.

To be entitled to examination as first assistant one must have used a second assistant's license at least 1 yr. and the stationary man without sea experience who has had full charge of a plant of at least 1000 hp. is eligible for examination as third or second assistant.

1. What are your duties in taking charge of a watch?
2. If your main check valve jammed, what would you do?
3. On a triple expansion engine your high-pressure crankpin broke. How would you proceed to run compound and what would you do?
4. If the vacuum suddenly dropped during your watch, what would be the cause and where would you look for the trouble?
5. Describe the different methods of forced and induced draft.
6. How long would it take a duplex pump, 12 in. in diameter, having a 14-in. stroke and making forty strokes per minute, to pump out a ballast tank, 20 by 20 by 4 ft. 6 in.?
7. What are stay tubes and how are they put in?
8. Name the causes of corrosion?
9. If you found about all the tubes in one box leaking during your watch, what would you do?
10. How many gallons will a tank 32 in. in diameter and 4 ft. 6 in. high hold?
11. How many gallons of water are there in a tank 9 by 9 by 5 ft. 4 in.?
12. A coal bunker measures 12 ft. at the top, 10 ft. at the center, 6 ft. 6 in. at bottom, 30 ft. long, 5 ft. high; how many tons will it hold?
13. Draw a perfect indicator card and name all the lines.
14. The ten ordinates of an indicator card measure 32 in., with a 40-lb. spring. What horsepower when the cylinder is 18.5 in. in diameter, 3-ft. stroke and 80 r.p.m.?
15. What is a salinometer and how would you make one for temporary use?
16. What is the average solid matter in sea water?
17. What is the effect of an eccentric too far back? Too far ahead?
18. If, when going full speed ahead, you received a signal to go astern and your ram refused to work, what would you do?
19. What effect on an egine has too little exhaust lap?
20. If your furnace crown came down during your watch, what would you do?
21. If you thought that your high-pressure cylinder was out of line with the crank shaft, how would you prove it?
22. How would you determine if the main shaft was in line with the crank shaft?
23. What are retarders and what advantage in using them and when?
24. What is the advantage of oil over coal as fuel?

RECEIVER.

Leak Stopped with Tin Foil

IN THE plant of which I have charge, a 7-in. gate valve on the steam line between the engine and main steam header developed a leak. Steam was blowing out around one of the bolts in the flange. Thinking that the gasket had given way, the joint was opened and cleaned, a new gasket inserted and the joint bolted up again. When the steam was turned into the line again, we still had the leak. On account of getting late in the day and our peak load coming on, we had to leave the job until the next day. Upon opening the joint next day, the gasket was found to be in good condition. So we had to look farther for the trouble.

By moving the pipe out of the way so that we could see in the end of the valve, we found a sand hole in the body of the valve about 1 in. back from the face of the flange on the valve, extending through the body and flange of the valve and coming out in one of the bolt holes in the flange. The problem now was to stop this leak without replacing this valve, as to do this it would be necessary to take two boilers off the line, which we could not do. Having on hand some tin foil that we had taken off friction tape and saved, I got some of it, and a small packing hook that would go inside the hole, and by twisting the tin foil into a rope small enough to enter the hole it was pushed up into the hole as far as it would go and then packed as tight as possible by using a small hammer and punch until the hole was full and packed solid. The flange was bolted up and the steam turned on, the leak was gone and has never returned. We carry 150 lb. pressure. The job required about 3 hr. time. O. V. B.

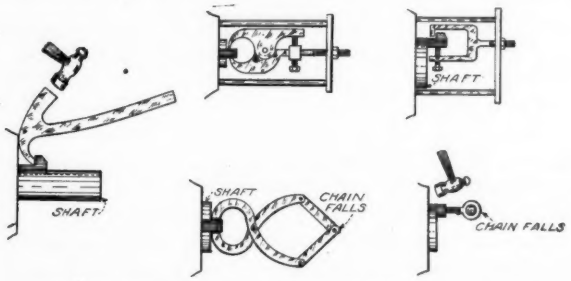
Boiler Room Clearance Spaces

MY OBSERVATIONS and experiences lead me to send in a protest directed to designers of power plants against the small amount of clearance spaces frequently provided for men to work in. The space between the red ash door and the building wall should be more than 2 ft.; there should be enough room in front of the boiler to get the clinker hook out without scraping the knuckles against the wall, and space enough should be allowed for scraping the tubes.

Another provision I would suggest is that of underfeed stokers in heating plants so that fine coal can be used, whereas with a hand fired grate, nothing but lump coal can be burned. HENRY PRIEBE.

Key Extractors

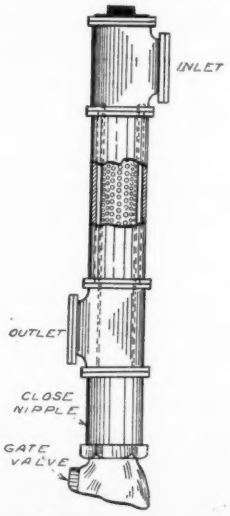
IN THE accompanying illustrations are shown various types of shaft key extractors. These sketches were submitted by C. H. Willey.



VARIOUS TYPES OF READILY MADE KEY EXTRACTORS

Improvised Basket Strainer

OUR COOLING WATER for the vacuum pump is taken from the penstock through 1¼-in. pipe. In this pipe we had a basket strainer. In the spring of the year we had a lot of trouble with the strainer becoming clogged; that meant taking off the top and cleaning the basket three or four times a day. I decided I would make a better arrangement than that. I took two 2-in. tees and



HOMEMADE, SELF-CLEANING STRAINER

connected them with a 2-in. nipple about 6 in. long, and bushed them down to 1¼ in. I then took some perforated brass and made a strainer, open at the bottom; and at the bottom of device I have a close nipple and a gate valve. When the valve is closed, all the water goes through the perforations to the vacuum pump. When the strainer becomes clogged, which it does just as frequently as it did before, all that is necessary is to open the valve at the bottom and the water rushes straight through, cleaning it in a very efficient manner.

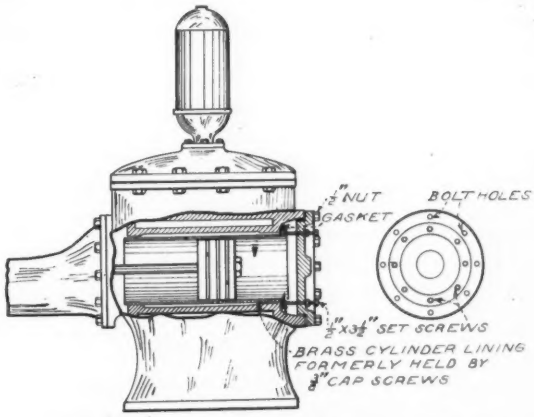
THE CHIEF.

Securing Pump Liner

THE METHOD used to repair the water end of a pump, which is described below, may prove of interest to readers of Power Plant Engineering.

On a Marsh simplex pump having a removable brass cylinder lining held in place by ⅜-in. cap screws through the flanged end of the lining into the body of the pump, the cap screws stripped and the holes were retapped for ⅝-in. cap screws.

These eventually stripped also and due to the fact that the water used has a corrosive action on cast iron, seeming to soften it to a depth of ⅛ to ¼ in. where exposed, I decided to hold the liner in place against its



METHOD EMPLOYED TO HOLD LINER IN PLACE

gasket and the pump body by putting set screws through the cylinder head and tightening the liner and gasket by means of them. The sketch shows the method used.

A little candle wick and some nuts on the set screws outside the head served to prevent leakage and loosening of the screws.

The pump is a 14 and 8½ by 12-in. unit.

R. BRUCE.

POWDERED COAL in piles weighs 38 to 45 lb. per cubic foot, solid particles have a specific gravity of 1.3 to 1.35. The free surface of a pile at rest make an angle of 34 to 38 deg. with the vertical, if dry.

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The Ship Situation

It is quite clearly understood that, on our ability to turn out and keep in service, ships sufficient to transport our troops and, to supply them and our allies with food and equipment, rests the victory in this war. Unless we can do this, we shall lose. If we do it, we shall win, soon or late, according to how earnestly the United States concentrates on the job.

As this matter of ships is vital, the figures recently given by Edward N. Hurley, chairman of the United States Shipping Board, showing what has been done, are of supreme interest.

After calling attention to the fact that it was impossible for the board to place any contracts at the time of our entry into the war with the shipyards then in existence, owing to the expansion of the navy and the contracts by private owners for ships, Mr. Hurley stated that on March 2, 1918, there were in construction, 235 new ways for steel ships and 259 new ways for wooden ships completed or nearing completion, making a total of 398 steel shipways, and 332 ways for wooden ships, as against 162 for steel and 73 for wood a year ago.

In one yard in Seattle, an 8800-ton steel vessel was launched in 64 days after the keel was laid, and at Oakland, three 9400-ton vessels were launched in a single afternoon. Up to March 1, 655,456 tons of steel shipping had been put into service, which is 150 per cent of all tonnage, both steel and wood, turned out by our yards in 1916.

Programs have been delayed by weather, by transportation difficulties and by labor scarcity, but Mr. Hurley estimated that, if these can be overcome, and the delays are growing less, the yards should turn out 2,300,000 tons of wooden ships annually, besides steel ships in proportion to the yard facilities.

In addition, the building of concrete ships of large capacity seems to be an assured possibility, as a ship of 4000 tons was launched in San Francisco on March 14, and is now being fitted with machinery. If a trans-ocean voyage proves her to be seaworthy, this gives an important added resource, for the building of concrete ships can be done rapidly, with a minimum of machinery and plant and at low cost.

It is to be hoped that nothing will be allowed to interfere with rapid realization of Mr. Hurley's estimates, and that every possible means will be employed to place the production of ship tonnage at a maximum at the earliest possible moment.

Power Plant Expenditures

Due to the unprecedented prices which today are being paid for fuel, and, in fact, all power plant supplies, operators as well as owners hesitate to make purchases of apparatus other than that absolutely necessary to insure continuous operation. Private interests and at the present time national welfare frequently appear to justify and sanction such action, but rightfully some limitation upon this practice is desirable, for many times, and especially in plants not equipped with apparatus by means of which the highest degree of efficiency may be realized, expenditures otherwise deemed unnecessary or even extravagant may bring returns in increased economy heretofore considered impossible of attainment.

Along what lines such expenditures may be made most profitably depends almost entirely upon local conditions, and it is only after a careful study of the plant, its past and present performances and the probable results which the apparatus under consideration for purchase may have upon the future efficiency of the plant that additions to equipment should be made.

It is, of course, reasonable to expect that before purchases of apparatus conducive to greater economy of operation are made, no effort has been spared to realize the utmost from the equipment in hand, and this can be done only by maintaining this equipment in first class condition and utilizing it to the best advantage. Little is to be gained, indeed actual losses may result from equipping the boilers of a plant with the highest grade of stokers, feed regulating devices, CO_2 recorders and other apparatus, and then neglecting to give them the proper care and attention which they require. But, on the other hand, if a plant is equipped with such devices and the operating force trained to use them properly, material benefits are bound to result, especially if the operators are allowed to share in the savings effected.

Prices of lubricants of all kinds are also continually rising, and it is nothing short of the grossest folly to depend entirely upon the human element for their proper application. Every operator is well aware of the fact that the greatest losses of oils and greases about a plant are occasioned by waste. It appears almost criminal for any engineer to continue operation of his plant without some form of efficient oiling system including separators and filters for the proper reclamation of these oils not actually used up in lubrication. This is especially true in the case of large plants in which material savings may be realized by the proper handling of this phase of operation. For small engines, many highly efficient and reliable forms of individual lubricating systems are on the market and where these have not been provided by the engine manufacturer, their immediate adoption appears desirable.

Wiping cloths and waste after once used for cleaning purposes, have heretofore, in the majority of instances, been relegated to the waste cans, and as a consequence much oil which might be saved to advantage, has been lost, not to mention the large amount of waste suffering a like fate. That the installation of some form of oil extractor and waste washing machine will prove a very profitable investment is without a question. The reclaimed oils may be employed for the lighter bearings, and the waste when washed will be found as serviceable as new.

Plant performance records are as accurate and as reliable only as are the instruments employed in making measurements, and unless these instruments are regularly calibrated, the monthly records will indicate results more apparent than real. No medium or large sized electric generating station should, therefore, be without a complete set of standard instruments by means of which the various switchboard ammeters, voltmeters, and wattmeters may be checked and calibrated at regular intervals. Within a short time, their initial cost will be absorbed by the savings effected.

Providing for Injured Engineers

Our fellow workmen are being called to the battle's front. They leave in the prime of physical condition, able to perform any work that is required of a man in their occupation. Undoubtedly many will return disabled for life, unable to follow their former lines of work. Many power plant men will be among this number. What can we do to provide positions for these men in the line of work with which they are most familiar? Are we compelled to bar them entirely from power plant work because they have lost a foot, a hand, an eye or the sense of hearing and consequently cannot compete fully with men of sound bodies?

Here is a problem we wish to put before our readers. It is the patriotic duty of those who remain at home to provide openings for these young men who have faced the terrors of warfare and paid for their citizenships in flesh and blood. Ambitious young men will not be content to live upon charity or a government pension; they will desire to exercise all the faculties they possess and to make their own way in the world, even though handicapped.

To accommodate ourselves to the changed conditions, undoubtedly many changes will have to be made in our system of organization. In the small plant there appears to be little hope for the man disabled to any extent; in larger plants, however, where the work is specialized, there are a number of positions requiring a knowledge of power plant operation and machinery, yet dependent but little upon the physical qualifications of the man.

Readers of Power Plant Engineering have undoubtedly had opportunities of observing the work of their fellows who have become disabled, yet carried on their work, or at least certain portions of it, in the power plant. Those who have had this opportunity can be of great service to their fellow men by describing to us the condition of the disabled man, what was the nature of the work he performed, how efficient he was in this work compared with an able bodied man and with what artificial devices he was equipped. This information will be given to our readers with the hope that those employing men may find places for our disabled soldiers which will be of mutual benefit.

Concrete and Brine

As a result of a series of investigations of the action of brine on reinforced concrete, Prof. H .J. M. Creighton in the Journal of the Franklin Institute concludes that: 1. All concrete that is not waterproofed in some way is more or less porous to water and brine. 2. Brine readily softens the surface of concrete and the more readily penetrates to the reinforcement, disintegrating the steel, causing it to expand and thus weakening the concrete so that it cracks and splits, even to fall away from the reinforcement. 3. Reinforced concrete floors in contact with brine will gradually develop leaks; followed by incrustation of discolored salt on the under side, later by hair cracks parallel to the reinforcements which gradually widen, until concrete will be pushed out and fall.

Electric Hoist for Handling Ashes

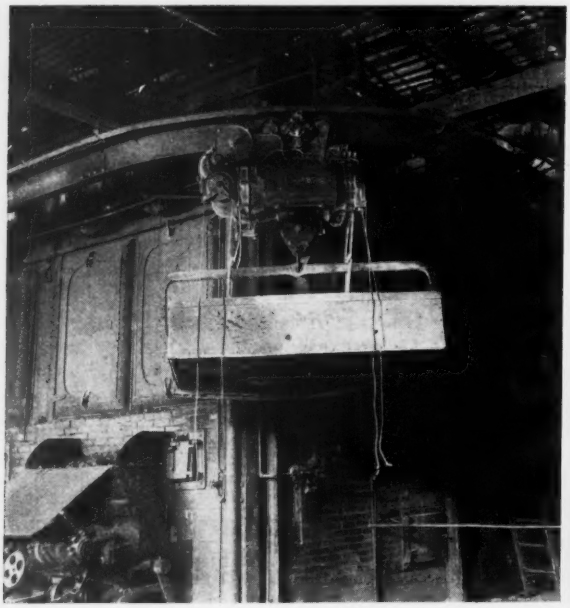
THE MATTER of improving the handling of ashes in old boiler-houses of small or moderate size, is such a frequent problem that it is thought interesting to relate here briefly how facilities in this respect were improved at the Pennsylvania State College, State College, Pa.

A little over a year ago, there was installed at this plant a d.c. mono-rail electric hoist, manufactured by Link-Belt Co., for handling the ashes from under Taylor stokers. Approximately 5000 lb. of ashes accumulate every 24 hr.

The system of handling is as follows: Every 8 hr. the ashes which accumulate on the dumping grates of the stoker are dumped into a steel tray 6 ft. 6 in. by 3 ft. 3 in. by 18 in. deep. This tray rests on a four-wheel truck. After dumping the grates, the truck is moved on a small-gage track to an opening where the tray is elevated by means of the electric hoist, and later carried to the ash dump approximately 300 ft. distant. It requires less than 10 min. to dispose of the ashes from under the boilers and return the tray in position for the next dumping of the grates.

The installation of this equipment is shown in the accompanying illustration. The hoist is equipped with a motor-driven trolley. The operator walks with the hoist and operates both controllers from below by means of cords. The rate of travel along the 10-in. mono-rail I-beam track is 125 to 250 ft. per min.

The gears are enclosed within metal housings, and operate in a bath of oil. No cast iron is used in tension. The two motors are of Crocker-Wheeler make, and the controllers of Link-Belt drum type. An electric brake holds the load the instant power goes off from any cause whatsoever and to prevent over-hoisting an automatic upper limit switch is provided.



ASH HOIST AND TRAY INSTALLED IN BOILER ROOM OF THE PENNSYLVANIA STATE COLLEGE

Atlas Enclosed Fuses

THE fundamental feature of these fuses, which are made exactly the same size as the ordinary fuse, is that four fuses are contained in the one case. The label on the outside contains four markings corresponding to the four fuses, and when the first fuse is blown, the space corresponding to this is marked with a cross indicating that it is out of commission, and the cap on one end of the fuse is pulled out, turned to correspond with No. 2 fuse, and pushed back into place, thus bringing the No. 2 fuse into service. A like operation is performed until all four fuses are gone.

EXTERIOR AND SECTIONAL VIEW OF ATLAS ENCLOSED FUSE

It is evident that the time for putting a machine back into commission on the blowing of a fuse is reduced to a minimum, and that there is certainty that the line will be fused for the same current at all times. The fuses are made by the Atlas Selling Agency, of New

York City, in sizes from 3 to 60 amp., 250 volts, cartridge ferrule type, and 65 to 100 amp, knife blade type. Higher amperages and 600-volt fuses are in process of development.

An Adjustable Spray Head

WHEN using a limited supply of water for cooling a condenser, it is necessary that the water be re-used, and this means that, after it has passed the condenser its temperature must be lowered so that it can again condense steam. One method employed is the spray pond in which the water finely divided by a head is partially evaporated by passing through the air, the heat for this evaporation being taken from the remaining water, which also gives up some heat by conduction and radiation to the air.

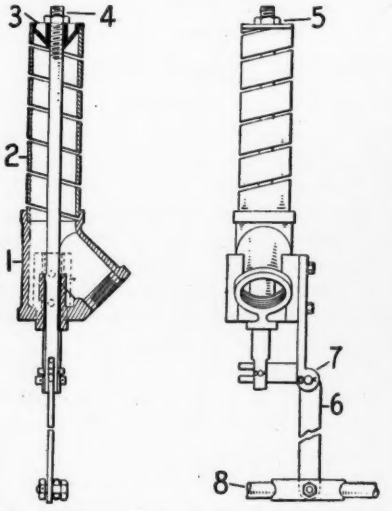


FIG. 1. SECTION AND ELEVATION OF YARWAY SPRAY HEAD

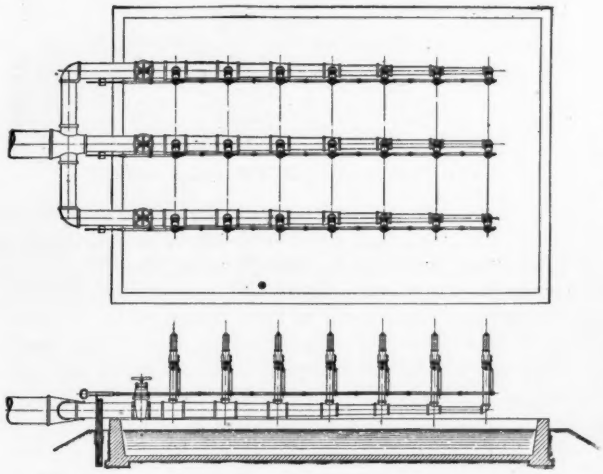


FIG. 2. LAYOUT OF SPRAY POND WITH THREE LINES OF HEADS

In this system the spray head is an important feature, for the effectiveness of cooling is found to depend on the fineness and form of the spray. In the Yarway adjustable head, shown in Fig. 1, herewith, the width of the helical slot is controlled by the rod, 8, which is connected to an entire line of heads and is operated from the shore of the pond by a regulating lever. This permits of closing the slot to build up pressure, opening it wide to flush and clean the nozzle, or setting at any width to give a desired capacity. The flow through each head is 75 to 100 gal. per min., with a pressure of 3 to 5 lb. By opening or closing the slot, the spray can be changed from a shower of small drops to a fine mist, as desired, according to capacity needed and weather conditions.

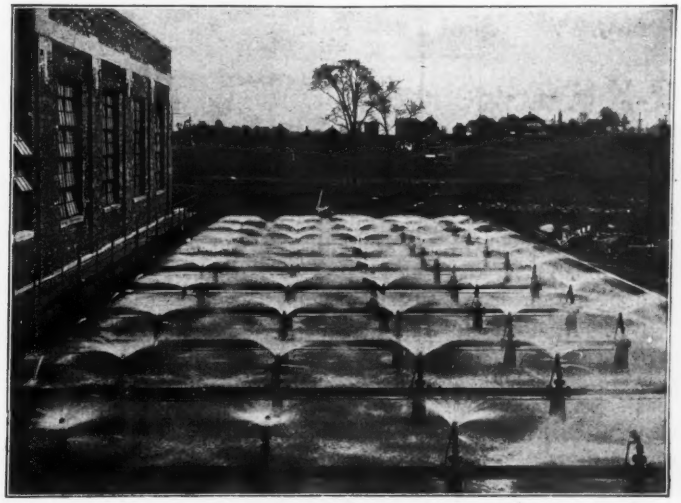


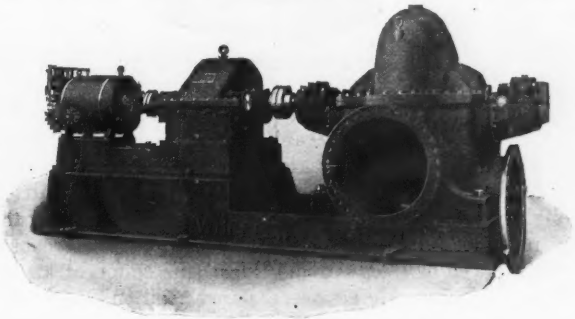
FIG. 3. VIEW OF A SPRAY POND AS INSTALLED

Figure 2 shows a typical layout of a spray pond with control valves and nozzle regulating levers.

The Yarway head is from patents of C. C. Thomas, and is manufactured by the Yarnall-Waring Co., of Philadelphia, Pa.

New End Suction Centrifugal Pumps

HEREWITH is illustrated a new design of pump manufactured by the Wheeler Condenser & Engineering Co., Carteret, N. J., that is of special interest because of the unusual position of the suction opening. This opening, it will be noted, is directly beneath and parallel to the end bearing. In this posi-



END SUCTION CENTRIFUGAL PUMP

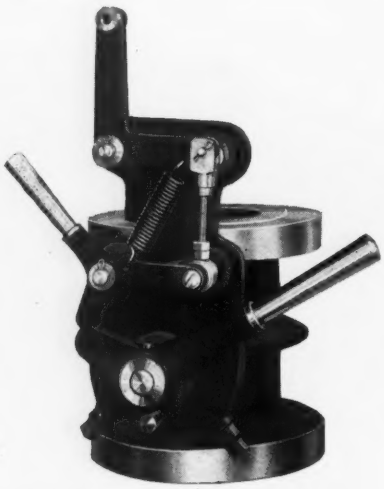
tion it is out of the way, yet it is in a convenient place for the erection men, for inspection, for upkeep, etc.

This arrangement makes it possible to place a pumping unit in a room of small ground area—considerably smaller than where the suction end is opposite the outlet end, as is the most common practice. In many cases this also facilitates the making of pipe connections, sometimes saving elbows and reducing the length of piping more or less.

The capacity of the particular pump shown is 45,000 gal. per min. against a head of 20 ft. The diameter of the outlet pipe is 36 in. The speed of the pump is 240 r.p.m. and is coupled by a 10 to 1 reduction gear to a steam turbine whose speed is 2400 r.p.m.

R-K Emergency Trip Valves

TO GUARD against the property damage and loss of life so frequently the result of a racing steam engine or turbine, the steam supply lines of such machines require being fitted with some form of valve which may be depended upon at all times to cut off the steam as quickly as any tendency to race occurs. A valve designed for such a purpose is that shown in the accompanying illustration and known as the R-K Emergency Trip Valve. It is manufactured by the Ruggles-Klingemann Mfg. Co., of Salem, Mass., in various sizes ranging from 2 to 14 in., inclusive, and is so constructed as to fit it for use on either horizontal or vertical lines.



THE R-K EMERGENCY TRIP VALVE

Ordinarily the governor rod which is attached to the upper arm of the bell crank is held in tension. With racing of the engine or turbine, however, this tension is released and the upper arm of the bell crank is shifted slightly to the right which through the medium of the adjustable valve trip rod and the tripping arm causes the valve to be released, and due to the action of an enclosed spiral spring assume a closed position. The tripping spring is so arranged that it serves a twofold purpose; first, that of releasing the valve on overspeed of the machine, and second, by holding the valve latched and preventing it from being unnecessarily tripped by vibration or jar when the engine or turbine may be operating at normal speed.

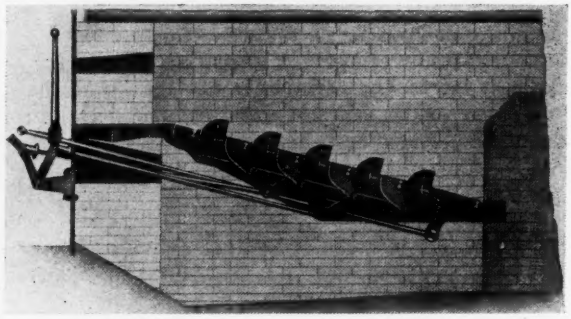
Tripping of the valve may also be accomplished by manipulation of the tripping lever shown at the left, and to facilitate replacing the valve into running position, the resetting lever shown at the right has been provided.

These valves are built with cast-iron bodies and bronze trimmings or cast steel bodies and Monel metal trimmings, as their service may require, and in order to accommodate local conditions they may be supplied with right or left-hand trip heads. Adjustments for horizontal or vertical pipe lines may be made by means of the four set screws shown.

The Huber Hand Stoker

A HAND STOKER, the results of the use of which are guaranteed to equal the performance of mechanical stokers and one in the construction of which there has been eliminated all troublesome and complicated mechanism, is the Huber hand stoker, manufactured by the Flynn & Emrich Co., of Baltimore, Md., and sold by Henry H. Hyde, of Chicago. Its initial cost as compared with mechanical stokers is said to be about one-fourth and its cost of upkeep, according to the manufacturers, is practically nothing.

Essentially this stoker, as shown in the accompanying illustration, consists of a series of flat grate bars, each backed with a curved shield and reinforced with end pieces to which are cast lugs for the support of the bars in trunnions on the sides of the framework of the stoker. Alternate bars are connected by means of pins



SIDE VIEW OF THE HUBER HAND STOKER

to a cast connecting-rod through the medium of which and a heavy rod, each set of bars may be caused to swing upward on their lugs by manipulating operating levers mounted on the boiler fronts.

Coal fed to the front of the furnace where it is partially coked, may, therefore, be uniformly and easily advanced toward the bridge-wall, according to the progress of combustion, and when this has been completed, the cinders have been delivered to a dump-grate which may be dropped by means of a third pull-rod at the front of the boiler and the cinders deposited into the ash-pit below. This operation permits of complete cleaning of the fire with the fire-doors closed and without the usual attendant loss of steam pressure.

With the alternate operation of the grates there is, in addition to the gradual advance of the fuel toward the bridge-wall, assured a complete, even and thorough

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POWER PLANT ENGINEERING

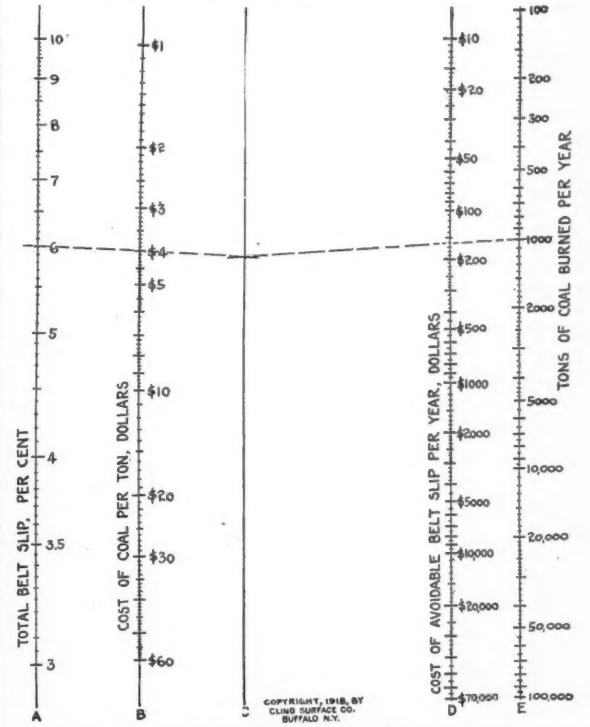
THEORETICAL WATER RATES PER KILOWATT HOUR
(Heat values from Marks & Davis' Steam Tables)

Suphtd. Deg. F.	26 in.	27 in.	27.5 in.	28 in.	28.5 in.	29 in.
150 LB. GAUGE						
0	11.80	11.23	10.92	10.55	10.12	9.52
25	11.61	11.05	10.74	10.38	9.96	9.44
50	11.42	10.87	10.58	10.22	9.81	9.30
75	11.24	10.71	10.41	10.07	9.66	9.17
100	11.07	10.55	10.26	9.92	9.52	9.03
125	10.90	10.38	10.10	9.77	9.38	8.90
150	10.75	10.23	9.96	9.63	9.25	8.78
160 LB. GAUGE						
0	11.66	11.10	10.79	10.43	10.01	9.50
25	11.45	10.91	10.61	10.26	9.85	9.34
50	11.26	10.75	10.45	10.11	9.70	9.21
75	11.10	10.58	10.29	9.95	9.56	9.07
100	10.92	10.41	10.13	9.80	9.42	8.94
125	10.75	10.25	9.98	9.66	9.27	8.81
150	10.60	10.10	9.84	9.52	9.15	8.69
165 LB. GAUGE						
0	11.57	11.03	10.73	10.37	9.96	9.45
25	11.39	10.84	10.55	10.20	9.80	9.30
50	11.20	10.68	10.39	10.05	9.65	9.16
75	11.02	10.50	10.22	9.89	9.50	9.02
100	10.83	10.35	10.08	9.75	9.37	8.89
125	10.68	10.18	9.92	9.60	9.23	8.76
150	10.52	10.04	9.77	9.46	9.10	8.64
170 LB. GAUGE						
0	11.50	10.96	10.66	10.32	9.91	9.40
25	11.31	10.78	10.49	10.15	9.75	9.25
50	11.13	10.61	10.33	9.99	9.60	9.11
75	10.95	10.45	10.17	9.84	9.45	8.98
100	10.79	10.29	10.02	9.70	9.32	8.85
125	10.62	10.13	9.86	9.55	9.18	8.73
150	10.47	9.99	9.73	9.42	9.05	8.60
175 LB. GAUGE						
0	11.44	10.91	10.61	10.27	9.87	9.36
25	11.25	10.72	10.44	10.10	9.70	9.21
50	11.07	10.55	10.27	9.94	9.55	9.07
75	10.89	10.39	10.11	9.79	9.41	8.94
100	10.72	10.23	9.96	9.64	9.27	8.81
125	10.55	10.07	9.81	9.50	9.13	8.68
150	10.40	9.92	9.67	9.37	9.00	8.56
180 LB. GAUGE						
0	11.37	10.85	10.56	10.22	9.82	9.31
25	11.18	10.67	10.38	10.05	9.66	9.17
50	11.01	10.50	10.22	9.89	9.51	9.03
75	10.83	10.34	10.06	9.74	9.37	8.90
100	10.66	10.17	9.90	9.60	9.23	8.77
125	10.49	10.02	9.76	9.46	9.09	8.65
150	10.34	9.87	9.61	9.32	8.96	8.52
185 LB. GAUGE						
0	11.31	10.79	10.51	10.17	9.77	9.28
25	11.12	10.61	10.33	10.00	9.61	9.13
50	10.94	10.44	10.17	9.84	9.46	8.99
75	10.77	10.28	10.02	9.69	9.32	8.86
100	10.60	10.12	9.86	9.55	9.19	8.73
125	10.43	9.97	9.72	9.41	9.05	8.61
150	10.28	9.82	9.57	9.27	8.92	8.49
190 LB. GAUGE						
0	11.25	10.74	10.46	10.12	9.73	9.25
25	11.06	10.56	10.28	9.96	9.58	9.10
50	10.88	10.39	10.12	9.80	9.42	8.96
75	10.71	10.23	9.97	9.65	9.28	8.82
100	10.55	10.08	9.82	9.51	9.15	8.70
125	10.39	9.92	9.67	9.37	9.01	8.58
150	10.23	9.77	9.53	9.24	8.88	8.46
195 LB. GAUGE						
0	11.20	10.69	10.41	10.08	9.69	9.22
25	11.01	10.51	10.24	9.92	9.53	9.07
50	10.83	10.35	10.08	9.76	9.38	8.92
75	10.66	10.18	9.92	9.61	9.24	8.79
100	10.50	10.03	9.77	9.47	9.11	8.66
125	10.33	9.87	9.62	9.32	8.97	8.54
150	10.18	9.72	9.48	9.18	8.84	8.42
200	9.86	9.43	9.19	8.92	8.59	8.18
200 LB. GAUGE						
0	11.15	10.64	10.37	10.04	9.66	9.18
25	10.95	10.46	10.19	9.87	9.49	9.03
50	10.77	10.29	10.03	9.71	9.34	8.88
75	10.61	10.13	9.87	9.57	9.20	8.75
100	10.44	9.97	9.72	9.42	9.06	8.62
125	10.28	9.83	9.58	9.28	8.93	8.50
150	10.13	9.68	9.44	9.15	8.81	8.38
200	9.81	9.39	9.15	8.88	8.55	8.15
205 LB. GAUGE						
0	11.09	10.60	10.32	9.99	9.62	9.15
25	10.90	10.41	10.14	9.82	9.45	8.99
50	10.72	10.24	9.98	9.67	9.30	8.85
75	10.55	10.09	9.83	9.52	9.17	8.72
100	10.39	9.93	9.68	9.38	9.03	8.59
125	10.23	9.78	9.54	9.24	8.90	8.47
150	10.08	9.64	9.39	9.11	8.77	8.35
200	9.77	9.35	9.11	8.84	8.52	8.12
210 LB. GAUGE						
0	11.04	10.55	10.28	9.97	9.59	9.12
25	10.85	10.37	10.10	9.79	9.42	8.96
50	10.68	10.20	9.94	9.63	9.27	8.82
75	10.50	10.04	9.78	9.48	9.13	8.69
100	10.34	9.89	9.63	9.34	9.00	8.56
125	10.19	9.75	9.49	9.21	8.87	8.44
150	10.03	9.60	9.35	9.07	8.74	8.32
200	9.73	9.31	9.08	8.81	8.49	8.10
215 LB. GAUGE						
0	11.00	10.51	10.24	9.93	9.55	9.09
25	10.79	10.32	10.05	9.75	9.38	8.93
50	10.62	10.16	9.89	9.59	9.24	8.79
75	10.46	10.00	9.74	9.44	9.09	8.66
100	10.30	9.85	9.60	9.30	8.96	8.53
125	10.14	9.70	9.46	9.16	8.83	8.41
150	9.98	9.55	9.31	9.02	8.71	8.29
200	9.68	9.27	9.04	8.77	8.46	8.06
220 LB. GAUGE						
0	10.95	10.47	10.20	9.89	9.52	9.06
25	10.75	10.28	10.02	9.71	9.35	8.90
50	10.58	10.11	9.85	9.55	9.20	8.76
75	10.41	9.95	9.70	9.40	9.06	8.63
100	10.24	9.80	9.53	9.26	8.93	8.50
125	10.09	9.66	9.42	9.13	8.80	8.38
150	9.94	9.52	9.28	9.00	8.67	8.27
200	9.64	9.23	9.00	8.74	8.42	8.03
225 LB. GAUGE						
0	10.90	10.42	10.16	9.85	9.48	9.03
25	10.71	10.24	9.98	9.67	9.32	8.87
50	10.53	10.07	9.81	9.52	9.17	8.73
75	10.36	9.91	9.66	9.37	9.03	8.60
100	10.20	9.76	9.52	9.23	8.90	8.47
125	10.05	9.62	9.38	9.10	8.77	8.35
150	9.90	9.47	9.24	8.96	8.64	8.23
200	9.60	9.20	8.97	8.71	8.40	8.01
230 LB. GAUGE						
0	10.86	10.39	10.12	9.82	9.45	9.00
25	10.66	10.20	9.94	9.64	9.28	8.84
50	10.48	10.03	9.78	9.48	9.13	8.70
75	10.32	9.87	9.63	9.34	8.99	8.57
100	10.16	9.72	9.48	9.70	8.86	8.45
125	10.01	9.58	9.34	9.06	8.74	8.33
150	9.85	9.44	9.20	8.93	8.61	8.21
200	9.56	9.16	8.93	8.67	8.37	7.98
235 LB. GAUGE						
0	10.81	10.35	10.09	9.78	9.42	8.96
25	10.61	10.15	9.90	9.60	9.25	8.81
50	10.44	9.99	9.75	9.45	9.10	8.67
75	10.27	9.83	9.59	9.30	8.96	8.54
100	10.12	9.68	9.45	9.17	8.83	8.42
125	9.96	9.54	9.30	9.03	8.70	8.29
150	9.81	9.40	9.16	8.90	8.58	8.18
200	9.52	9.12	8.90	8.64	8.33	7.95
240 LB. GAUGE						
0	10.76	10.31	10.05	9.75	9.39	8.94
25	10.57	10.12	9.86	9.57	9.22	8.78
50	10.38	9.95	9.70	9.41	9.07	8.64
75	10.23	9.79	9.55	9.26	8.93	8.51
100	10.08	9.65	9.41	9.13	8.80	8.39
125	9.92	9.50	9.27	9.00	8.67	8.27
150	9.97	9.36	9.13	8.86	8.55	8.15
200	9.48	9.09	8.87	8.61	8.31	7.93
245 LB. GAUGE						
0	10.73	10.27	10.01	9.71	9.35	8.91
25	10.53	10.08	9.83	9.53	9.18	8.75
50	10.35	9.91	9.67	9.38	9.04	8.61
75	10.19	9.76	9.52	9.23	8.90	8.48
100	10.03	9.61	9.37	9.09	8.77	8.36
125	9.88	9.47	9.23	8.95	8.64	8.24
150	9.73	9.33	9.10	8.83	8.52	8.12
200	9.43	9.04	8.82	8.57	8.27	7.90
250 LB. GAUGE						
0	10.69	10.23	9.98	9.68	9.33	8.89
25	10.49	10.04	9.79	9.49	9.15	8.72
50	10.31	9.87	9.63	9.34	9.01	8.59
75	10.15	9.72	9.48	9.20	8.87	8.46
100	9.99	9.57	9.34	9.07	8.74	8.34
125	9.84	9.43	9.20	8.93	8.61	8.22
150	9.69	9.29	9.06	8.80	8.49	8.10
200	9.41	9.02	8.80	8.55	8.25	7.88

—General Electric Review.

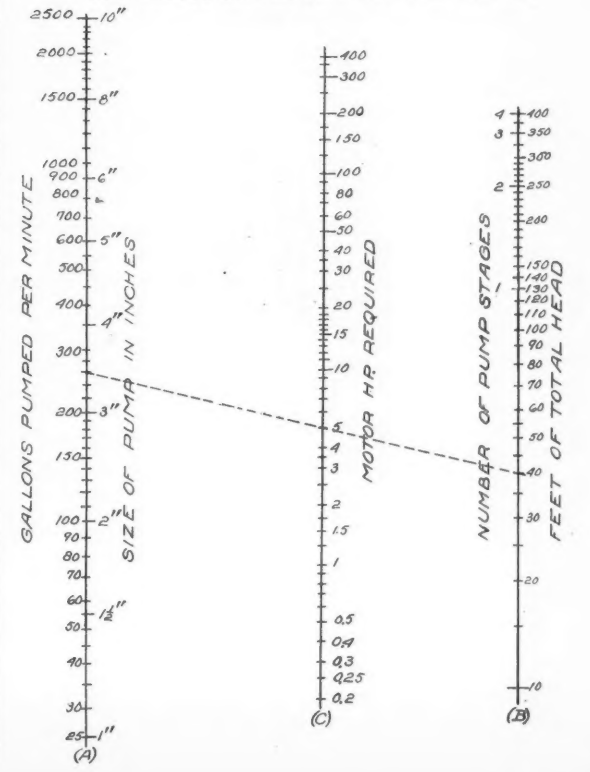
POWER PLANT ENGINEERING

CHART FOR DETERMINING COST OF AVOIDABLE BELT SLIP



POWER PLANT ENGINEERING

CHART FOR COMPUTING SIZES OF DRIVING MOTORS REQUIRED FOR VARIOUS CENTRIFUGAL PUMP CAPACITIES



POWER REQUIRED FOR CENTRIFUGAL BOILER FEED PUMPS

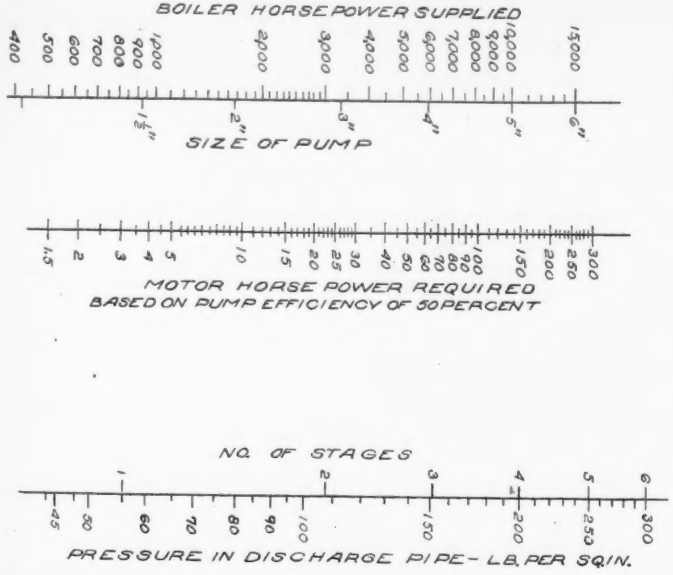
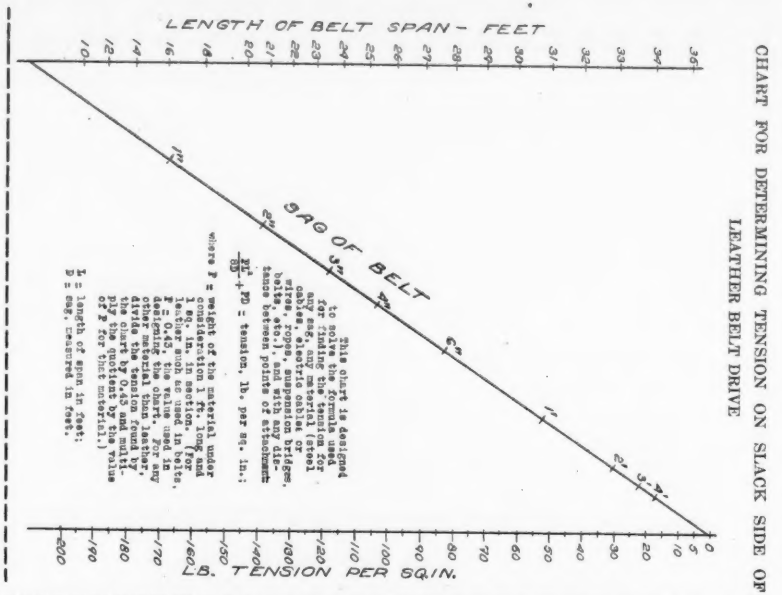
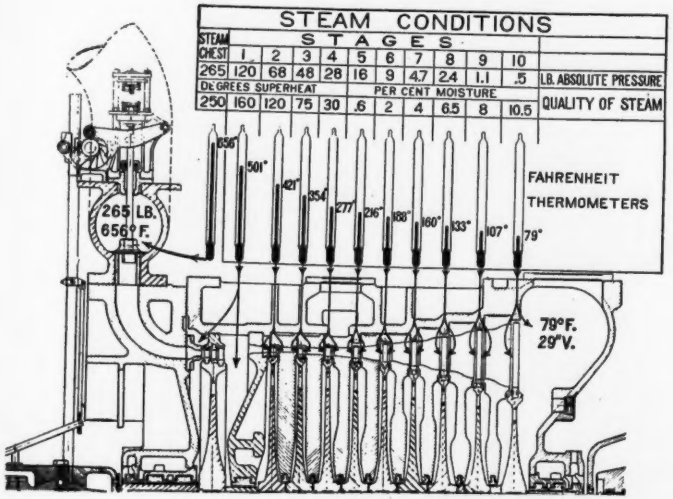


CHART FOR DETERMINING TENSION ON SLACK SIDE OF LEATHER BELT DRIVE

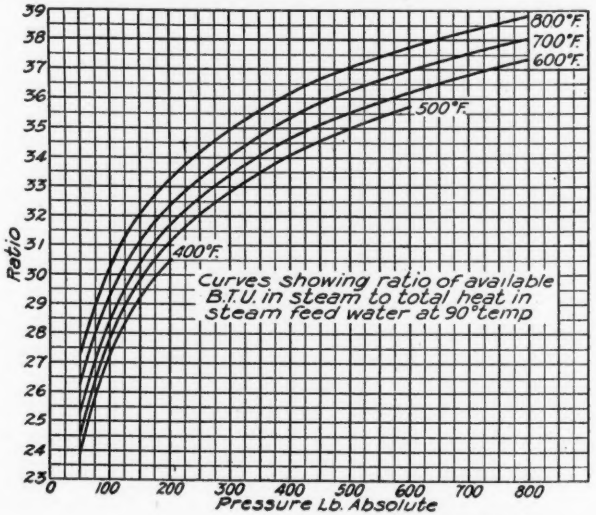

LENGTH OF BELT SPAN - FEET
10 12 14 16 18 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 36
SAG OF BELT
½" 1" 1½" 2" 2½" 3" 3½"
This chart is designed to obtain the tension for fixing the tension for any use, any material (steel cables, electric cables or ropes, suspension bridges, belts, etc.) for any length of span between points of attachment.
T = tension, lb. per sq. in.;
where F = weight of the material under consideration 1 ft. long and 1 sq. in. in section. (For example, the value used in the chart. For any other material than leather, divide the tension found by the value of F for that material.)
L = length of span in feet;
S = sag, measured in feet.
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 5 0
LB. TENSION PER SQ.IN.

SECTION OF 10-STAGE TURBINE SHOWING CONDITION IN EACH STAGE


STEAM CONDITIONS
STAGES
STEAM CHEST 1 2 3 4 5 6 7 8 9 10
265 120 68 48 28 16 9 4.7 2.4 1.1 .5 LB. ABSOLUTE PRESSURE
DEGREES SUPERHEAT PER CENT MOISTURE
250 160 120 75 30 .6 2 4 6.5 8 10.5 QUALITY OF STEAM
656° 501° 421° 354° 277° 216° 188° 160° 133° 107° 79°
FAHRENHEIT THERMOMETERS
265 LB. 656° F.
79° F. 29" V.

—General Electric Review.

PERCENTAGE HEAT OF THE STEAM AVAILABLE TO CONDENSING STEAM TURBINES


800°F.
700°F.
600°F.
500°F.
400°F.
Curves showing ratio of available B.T.U. in steam to total heat in steam feed water at 90° temp
Ratio
39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23
0 100 200 300 400 500 600 700 800
Pressure Lb. Absolute

—General Electric Review.

breaking up of the fuel bed without the use of a slice bar, the sifting of the finer ashes through the grates and no mixing of green fuel with the ashes.

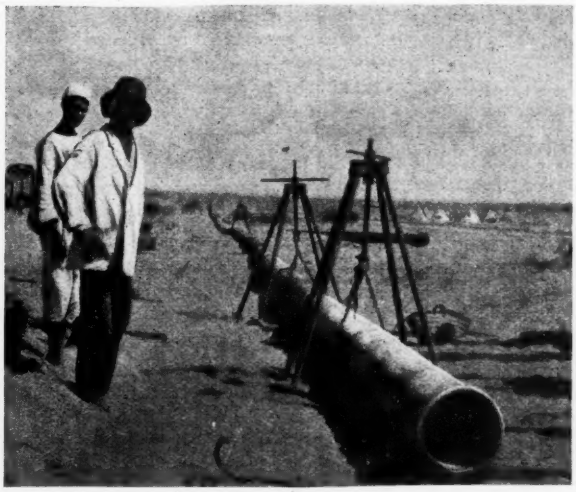
The curved shield of the stoker-bar, it is claimed, provides a constant air space regardless of the stoker-bar position, prevents fuel passing through large gaps and eliminates trouble due to clinkers locking the bars.

The stoker-bars are designed to give 50 per cent air space and due to the form of construction employed, their strength is considerably greater than that of the ordinary form of bar; warping is practically impossible.

News Notes

H. W. JOHNS-MANVILLE Co. announces the removal of its Memphis office to new quarters at 804-5 Exchange Bldg., Cor. Madison Ave. and 2nd St., Memphis, Tenn.

A NOTABLE ACHIEVEMENT in connection with the campaign of the British forces in Palestine is the supplying to the troops, during their entire march in crossing the Sinai desert, of fresh water pumped from Egypt through an American pipe line. This line and a broad gage railroad were laid for 150 mi. clear across the desert, the line being carried on the surface of the



ground, of 12-in. steel tube. At certain points in Egypt, tube wells were drilled from which the supply of water was obtained, and this was pumped through the line which was carried on to keep pace with the advance of the troops. This is simply another indication that success in carrying on military operations at the present time is dependent on the work of the engineer.

L. G. EDWARDS, for several years connected with the Advertising Department of the National Tube Co., has accepted a similar position with the Publicity Department of the A. M. Byers Co.

U. S. CIVIL SERVICE COMMISSION announces the following examinations, applications for which will, until further notice, be received at any time: Assistant inspector of cannon (forging operations), assistant inspector of cannon (machinery operations), assistant inspector of machine guns, inspector of gun carriages, assistant inspector of gun carriage, assistant inspector of gun-carriage parts, inspector of small arms, assistant inspector of small arms, assistant inspector of artillery wheels, assistant inspector of gun-carriage forgings, assistant inspector of castings, assistant inspector of steel mill products, inspector of small-arms ammunition, assistant inspector of small-arms ammunition, assistant inspector of gunfire control instruments, accessory inspector—small-arms ammunition, ballistic inspector—small-arms ammunition, inspector of material for small arms, assistant inspector of material for small arms, inspectors of artillery ammunition, mechanical draftsman, production clerk.

Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

H. D. SAVAGE, who has been vice-president of the American Arch Co. since 1914, has been elected vice-president of the Locomotive Pulverized Fuel Co. He will also continue to act in his former capacity. Mr. Savage has been active in the fire brick industry and was largely instrumental in building up the business at Ashland, Ky., to one of the largest plants in the country. He also helped to organize, and was elected first president of the Refractory Manufacturers' Association.

Catalog Notes

IT IS well understood that the percentage of CO_2 in boiler flue gases is a good indication of the effectiveness of furnace action, hence the reprint of a paper on Importance of High Test of CO_2 in Boiler Flue Gases and Automatic Analysis and Record, by A. T. Baldwin, delivered before the Detroit Engineering Society, is especially timely, now that coal saving is one of our most essential requirements.

This paper deals with the components of coal and their effect on its value as a fuel and its action in the furnace; determination of the correct air supply; losses in the boiler and how to reduce them; and how CO_2 analysis and recorders are used to assist in this work. Details of some conditions found and remedies applied in plants are given, also the details and method of operation of the Simmance-Abady CO_2 Recorder, and how to connect it and care for it.

Those wishing a copy of the booklet, which is well worth studying, can get it from the Precision Instrument Co., 200 Kerr Bldg., Detroit, Mich., by mentioning Power Plant Engineering when writing.

WELDING AND CUTTING apparatus made by Messer Mfg. Co., of Philadelphia, is illustrated in a recent publication, including a portable oxy-acetylene generator, stationary acetylene generator, portable welding equipment for the use of acetylene and oxygen compressed in tanks, portable cutting equipment, welding blow-pipes, cutting blow-pipes, oxygen and acetylene regulating valves.

FROM THE GRATON & KNIGHT Mfg. Co., Worcester, Mass., we have received Catalog No. 6, of 120 pages, containing description and illustration of the

company's leather specialties, describing processes in the different departments, and giving mechanical rules regarding belting; also various useful tables.

MANZEL BROTHERS CO., Buffalo, N. Y., has lately issued a circular relating to Manzel pumps and force feed oilers.

HISTORY of the Greenfield Tap & Die Corporation, Greenfield, Mass., is related in a pamphlet issued by the company on the occasion of the formal opening of the Administration Building.

STRATTON AIR SEPARATORS Bulletin 1109-C of the Griscom-Russell Co., 90 West St., New York, shows by illustrations how the separators can be changed in design to meet the demands of special piping, and gives a table of approximate dimensions.

MONTHLY SALES SERVICE for April, issued by the Society for Electrical Development, contains a multitude of helpful suggestions as to timely advertisements to sell electrical appliances and increase the use of electricity in the home. The society furnishes booklets and plans at cost for conducting selling campaigns on electrical devices and on house wiring, and also cuts for the ads, shown in the Sales Service pages.

Trade Notes

FOR THE BETTER SERVICE of the shipbuilding and allied interests, Tacoma, Wash., as well as the constantly increasing number of manufacturing plants, the H. W. Johns-Manville Co. has opened a new branch office at 1015 A St., Tacoma. Here is carried a complete stock of asbestos packings, molded and in sheet form, and other Johns-Manville power plant specialties.

Tacoma's port business has increased 300 per cent over 1913—the highest pre-war total—with a higher figure expected because of its natural shipping facilities its connection with the Far East trade and the C. M. & St. P. railroad's agreement with the Japanese lines. To these commercial advantages have been added six huge shipbuilding plants, turning out both wooden and steel ships.

HAWES FOUNDRY & INSTRUMENT CO., with a capitalization of $250,000, has just announced the recent acquisition of the Central Bronze Co., which concern will co-operate with its other plants in turning out a complete line of bronze valves and fittings used in connection with steam engineering, industrial and shipbuilding work.

This company also announces that all its products will be marketed and distributed as in the past, through its principals, the John Wilfert Co., of New York.

THE WESTINGHOUSE Electric & Mfg. Co. has leased for a period of years, the Baxter Stove Co., Mansfield, Ohio, with the intention of consolidating at this plant the manufacture of its heating appliances now being carried on at some of the other Westinghouse plants.

THE NAME of J. D. Barnhill, Incorporated, has been changed to Dodd-DuBosque Co., Inc., with offices at 110 W. 34th St., New York City. The business of sales plans and advertising campaigns will be continued as heretofore.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.

(Established over 22 years.)

PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

SUBSCRIPTION RATES

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill.

Member Associated Business Papers.

Member Audit Bureau of Circulations.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

DISPLAY ADVERTISING RATES

Full page, one year, each insertion, $66.00.

Half page, one year, each insertion, $38.50.

Quarter page, one year, each insertion, $22.00.

Eighth page, one year, each insertion, $13.25.

Front cover, $175.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Three line parallel 3-point border rule used.

Stippled plates used, but no heavy, black and white plates.

CLASSIFIED ADVERTISING RATES

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy and cuts should be received at Chicago Office eighteen days prior to date of publication.

Circulation of this issue, 23,600.

Technical Publishing Company

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By engineer experienced with producer gas and oil engines, a.c. and d.c. equipment, pumps, storage batteries, interior wiring and repair work. Technical graduate. References. Address Box 501, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-15-1

POSITION WANTED—By experienced fireman and engineer who has had charge of waterworks plants, and effected saving of half the coal bill by overhauling the plant. Familiar with electrical work. Address Box 507, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-15-1

POSITION WANTED—Power station draftsman, electrical graduate, experienced in power and substation layout work. Six years in present position with large manufacturing concern. Desires change. Address Box 511, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-15-1

POSITION WANTED—By a practical high- and low-pressure pipe fitter. Age 35 years. Would like to become connected with reliable concern as general pipe fitter or foreman. Address Box 512, Power Plant Engineering, 537 S. Dearborn St. Chicago Ill. 3-1-5

POSITION WANTED—By a competent electrician and engineer; 34 years of age; married; strictly sober and energetic. Willing to take complete charge of electric light plant or will take charge of power installation or operation. Present salary $150. Desire change with larger opportunity. Address Box 515, Power Plant Engineering, 537 S. Dearborn St. Chicago Ill. 3-15-4

POSITION WANTED—As chief engineer, 13 years experience with Corliss and high-speed engines, electrical and refrigerating machinery. Sober and reliable. Best of references. Address Box 518, Power Plant Engineering, 537 S. Dearborn St. Chicago, Ill. 4-1-2

POSITION WANTED—By middle aged man and chief engineer's license. Can handle d.c. and a.c. machinery, steam boilers, gas and oil engines. Also experienced in wiring and repair work. Address Box 508, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-6

POSITION WANTED—By an engineer with 13 years' experience with boilers, engines, electrical and refrigerating machinery. Wishes to connect with a permanent, reliable concern. Am familiar with flue gas analyzing instruments and furnace efficiency methods. Address Box 509, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 2-15-4

POSITION WANTED—To take charge of plant as superintendent. A1 electrician. Salary $150. For further particulars write Box 520, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-14-1

POSITION WANTED—By electrician, experienced with modern wiring, meter testing and reading. Best of references. 4 years experience. Will go anywhere. Address Carl H. Menke, 715 W. Commercial St., Kahoka, Mo. 4-15-1

POSITION WANTED—As engineer in small plant by young man. Over 5 years experience in grain elevator. Steady and sober habits. Good mechanic. Write R. Siebke, Walcott, Iowa. 4-15-2

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—A competent refrigerating engineer in Western Pennsylvania. Must be familiar with raw water and ice making system and electric machinery. State salary wanted. Address Box 505, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—A good fireman to take charge of shift in central station, 1680 hp. of Stirling boilers, chain grate stoker. Address Box 519, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-1-2

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial to put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 hp. to 250 hp. The Pittsburg Boiler & Machine Co., Pittsburg, Kan. tf.

WANTED—Agents handling engine and boiler room specialties in every section of our Boiler Girth Seam Protector. Liberal inducements. Give experience and territory covered. Address National Boiler Protector Co., Dayton, Ohio. tf.

WANTED—Kelley's Engineer's Examiner. Anyone having a copy of this which he will sell please write, giving price and condition. Address Box 516, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 3-15-2

WANTED—Engineers in their spare time and salesmen who carry side lines and visit engineers to sell the Selden and Zena packings. Both packings have shown their worth by use in largest plants. Randolph Brandt, 70 Cortlandt St., New York. 3-15-6

AGENTS WANTED—Salesmen calling on power plants to handle established nationally advertised product backed by a direct-by-mail campaign that "follows through;" liberal commission. Write today for our proposition. % Box 521 Power Pant Engineering, 537 S. Dearborn St., Chicago, Ill. 4-15-2

For Sale

FOR SALE—BOILERS. Two 150 hp. H. R. T. Boilers, butt strapped construction, 120 lb. pressure, $1000 each. 400 hp. Atlas Watertube Boiler with Murphy Stoker and Superheater, built for 210 lb. pressure, 4 years' service, $5000. Power Machinery Exchange, Inc., Jersey City, N. J. tf.

FOR SALE—Indicator, outside spring trill, suitable for steam or gas engine, with full set of springs, scales and reducing wheel outfit in hardwood case. Good as new. Also planimeter in leather case with full directions. Price reasonable. H. W. Jones, 955 Monadnock Bldg., Chicago, Ill. 4-1-2

FOR SALE—Boilers (with stokers):

	H.P.	Make	Pressure	Each
Four	400	B. & W.	150	$6000
Three	375	Heine	150	5500
One	306	Heine	175	6000
One	225	Heine	175	4500

Power Machinery Exchange, Inc., Jersey City, N. J.

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St. N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

FACTORY MANAGERS, ENGINEERS AND OWNERS—Coal is high and scarce. Let us tell you how to conserve it and utilize your exhaust steam for heating and drying purposes. Address Monash Engineering Co., 1413 W. Jackson Boulevard, Chicago, Ill. tf.

Sparks From The Advertising Pages

Where Buyers and Sellers Meet

Giving Hostages to Fortune

Ruthless conquerors have ever snatched the great, the rich, the beautiful, from among conquered peoples and carried them off in captivity as a guarantee against revolt when the iron fist should be withdrawn.

So the Romans took the fairest of the golden-haired youths from ancient Britain; so Attila and his Huns raped the lands they overran, so the modern Hun holds the provinces he has polluted—their peoples bodily in subjection, but with spirit unconquerable.

These unhappy captives are hostages for their people; theirs to suffer vicarious atonement for the acts of the brothers, sons and parents left behind them.

Among civilized peoples the tactics of war have changed, and ruthlessness is being driven from the earth, never to return.

Modern business is war; industry is a battle; competition is the fiery sword that drives the modern business man from his false ideal of a monopolistic Garden of Eden.

In this new war of business, **ability, honor** and **service** are the sword, the shield and the buckler that replace the ruthlessness of cut-prices, shoddy materials and poor workmanship.

But the giving of hostages still survives in this modern competition. For every man who enters the business arena gives hostages to fortune — puts up a stake in the hands of his judges, his buying public, that he will observe the rules, play fair and fight the good fight with the weapons of ability, honor and service—and these alone.

These hostages to fortune, these stakes he puts up, all center in his good name. If he means business, he is constantly backing it with his cold, hard cash.

In POWER PLANT ENGINEERING you will find, posted high where all may see, the hostages that certain representative business firms have put up as pledges to this vast audience of power plant men—pledges that they will play fair with those who buy from them.

In these advertising pages they give their pledge to the readers that they will meet all comers in fair contest with ability, honor and service as the only weapons to win favor.

To back these public claims, they have put up thousands upon thousands of dollars in experimenting, testing, trying, changing, until they know there is no flaw in their product. Then they turn the spotlight of publicity on it that you may see for yourself.

Buy from these firms who give hostages to fortune; who have backed their claims with high stakes; who display their product in the spotlight of pitiless publicity; who have everything to lose and nothing to gain by selling you anything but the best. Buy from the advertising pages of POWER PLANT ENGINEERING.